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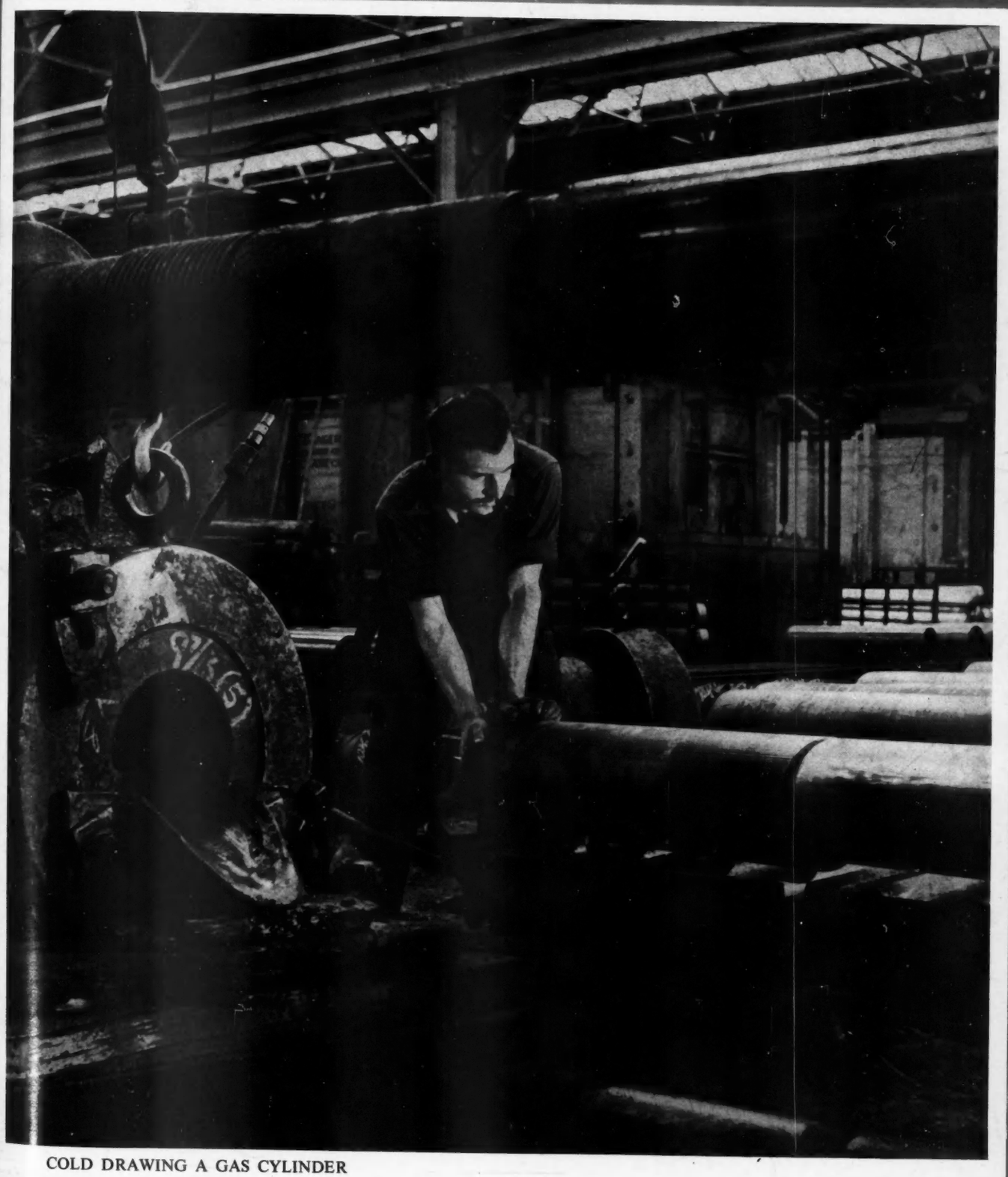

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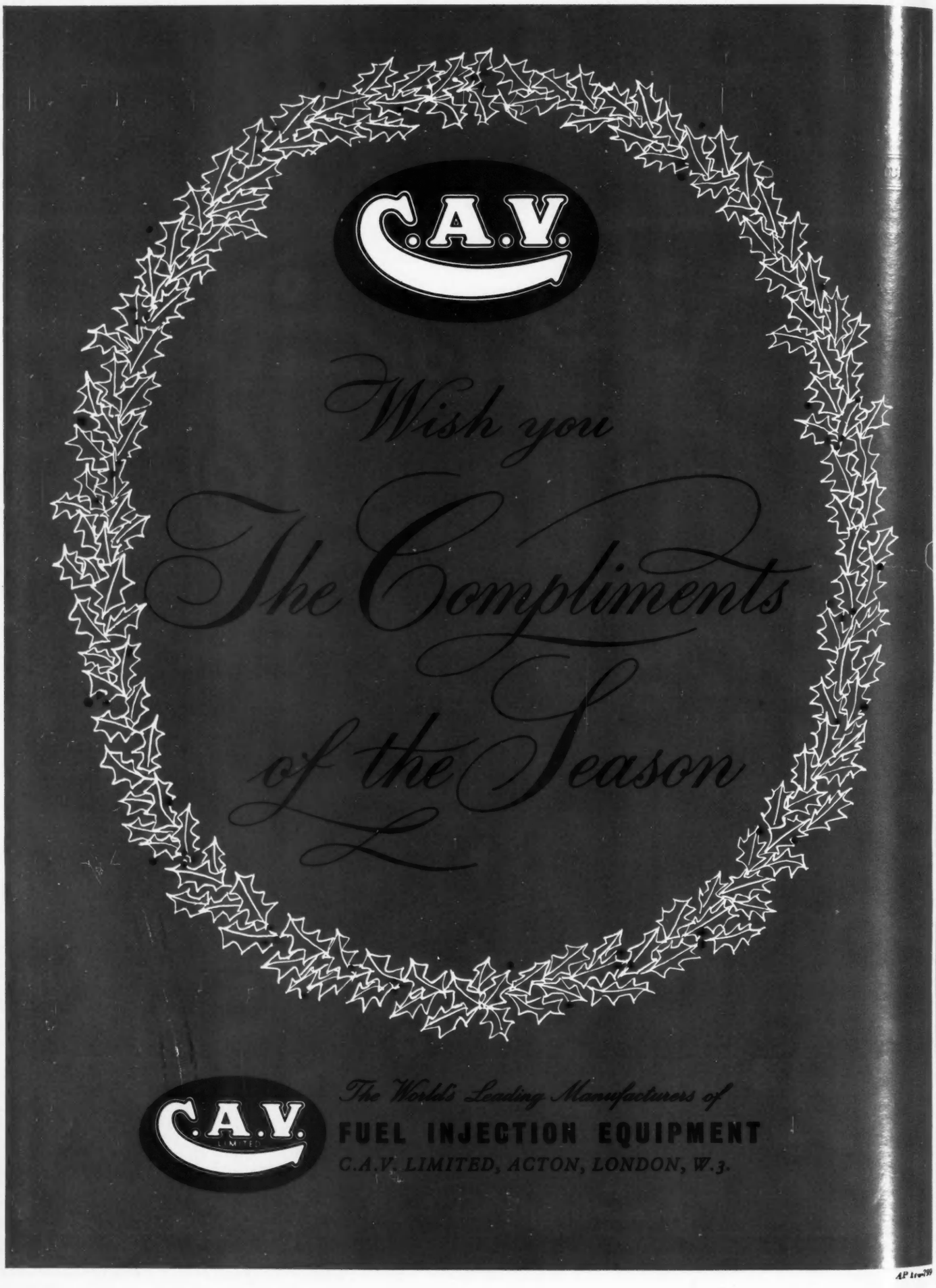
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An Illustrated Weekly Journal

Vol. 180 No. 4691 DECEMBER 23, 1955

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DIMINISHING RETURNS

It is sometimes thought that the more people engaged on a project the quicker it will be carried out and the more successful will be the result. But this is not always true; every company director knows that there is an optimum size for a given project, and most research workers have felt at some time that membership of a large staff makes it difficult to see the wood for the trees. It is in fact in research and development that overcrowding can be most harmful, for research is not only the methodical study of details but also the channelling of imagination —and imagination is not a corporate activity.

This seems to be borne out by some comments made last week by Mr. T. R. Thompson, a director of Leo Computers, Limited, who has recently returned from the United States, where he has been studying electronic-computer developments. His remarks suggest that although large wealthy organisations can deal efficiently with a mass of component problems, the comprehensive overall problem, with its call for imagination and an understanding of first principles, can best be tackled by an individual or small group. Mr. Thompson gave it as his opinion that his own company was ahead of the United States. He has warned this country, however, that we shall be hard pressed to retain our lead.

It will be recalled that the Leo system of machines was designed to carry out clerical work at high speed without any human intervention from beginning to end. Hitherto, clerks have acted as intermediaries between different machines, so that the overall time for a job was still governed by the clerks' rate of working. Leo was conceived as a challenge to this problem. The core of the system, known as Leo I, was a high-speed computer. A second system, Leo II, has been put into operation incorporating improvements made to the first system. From the start, therefore, Leo computers have aimed to introduce automation into the office. There are a number of other machines on the market which may be more versatile and faster as computers, and some of course are computing machines which are introduced into punched card systems and are thereby governed to some extent by the rate of input of information from the cards. Leo, however, represents a British solution to the problem of automation in the office solved from first principles.

Many hundreds of computing machines are being built in the United States, according to Mr. Thompson, and have been ordered by large business and Government organisations. Technically, they are excellent machines and a great deal of time and money have been spent on research. It is interesting that Mr. Thompson quotes a figure of £100,000 as the annual hire for one of these machines, a figure which may be compared with about £75,000 as the purchase price for a Leo II system. It is possible in this country to buy a high-speed versatile computer for £25,000, and many can be hired.

In the United States the main development has been to re-design machines originally produced for mathematical work, with faster means of feeding information in and out of them. According to Mr. Thompson they have not succeeded in making the necessary fundamental changes in the method of organising the flow of information within the computer which will enable it to work automatically from beginning to end. It is this ability to operate a completely automatic system which constitutes the lead held by this country at present.

This may be the beginning, however, of a familiar story. The amount of research work, experience gained from prototypes, and the general interest shown by American business in the development of computers is building up into a tremendous accumulation of energy and "know-how." It is estimated that there are over 10,000 people in the United States who have been through a course in computers of one kind or another. Once the ability to organise an automatic office is gained there will clearly be a tremendous pressure to install it in large and medium-sized American concerns. It is this enormous build-up which constitutes the danger to this country's slender lead.

But it is our small resources which may paradoxically serve as an advantage. The law of diminishing returns applies both to money and to people, and although we fling more and more of each into a development, results will not improve in proportion, and, in fact, returns per unit investment may decrease. Large numbers taking part in a venture may also limit its progress for other reasons: they may not fall over each others feet, but by the necessary demarcation of function and division of duties, original thinking on a large scale may be inhibited; what is more, sight may be lost of the final purpose of the work.

Perhaps this is what has happened in America; an attempt has been made to solve the office-computer problem before the problem itself has been properly formulated. Consequently, development has been piecemeal and the separate solutions do not fit together to make a satisfactory whole. Britain, which has a history of creative and imaginative industrial discovery, has a chance therefore of remaining abreast of technical progress, even without vast resources. But there is no cause for complacency; the Americans may be further ahead than we think.

Weekly Survey

Cover Picture : *In the production of seamless steel gas cylinders the final wall thickness is achieved by cold drawing. The photograph shows a gas-cylinder hollow being pushed on to a cold-drawing mandrel prior to being drawn through the die seen on the left. The die is mounted in the fixed cross-head of a horizontal hydraulic press.*

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The Market for Motor Cars

Cars have never figured very prominently in the Christmas buying spree, and it may well be that the recent decline in car sales reflects the normal seasonal winter fall-off. At any rate, motor manufacturers do not appear to be worried. Production schedules are to be maintained and stocks built up in expectation of a revival in demand early in 1956. Between 10 and 12 per cent. of orders, however, are said to have been cancelled for a variety of reasons not necessarily associated with the credit squeeze. A 1956 date stamp will be better for an eventual second-hand sale than a car registered in the preceding year and it is not surprising that second-hand car prices have weakened seasonally. In fact, all the normal seasonal signs of lower sales are evident with no great reason to suppose that hire purchase restrictions and the credit squeeze are in themselves affecting sales to a marked extent, though they are clearly having some influence.

The long-term trend is more likely to be accurately reflected in the state of demand in the spring of next year. There has already been some slight decline in hire-purchase sales, but hitherto business has been running at higher levels than in the same period of 1954. Of course, it is quite possible that there would in any case have been some slackening in domestic car sales. In Germany, where the motor-car tax was reduced early this year, domestic sales are becoming more difficult.

The real problem continues to lie in selling more cars abroad, and United Kingdom manufacturers can expect an even greater intensification of competition from Germany in this sphere should the present trend in their domestic sales continue. It is the aim of Mr. Butler to force British motor manufacturers to sell more abroad, and while trends in Germany are encouraging the export drive through a reduction of domestic demand, the Chancellor is hoping in the new year to accentuate this trend in this country as well when the full effects of the credit squeeze and hire-purchase restrictions become felt. Indeed, United Kingdom manufacturers must face this fact at least for the next four months until they see what the 1956 budget brings. Both countries are stepping up their export drive (under the stimulus of economic conditions and not at the behest of the manufacturers) at the same time. Meanwhile, potential sales abroad continue to be the main justification of present expansion plans both in this country and on the Continent.

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Productivity at Joseph Lucas

One British firm which has been successful in the Canadian market is Joseph Lucas (Industries), Limited, whose annual general meeting was held at Birmingham last week. Addressing the shareholders, Mr. A. B. Waring, the chairman of the company, said that while sales to the aircraft industry were greater than last year, this achievement was assisted by an increased contribution from the company's factory at Toronto. In considering the aircraft industry as a whole, however, Mr. Waring was of the opinion (held by most informed businessmen) that the peak of aircraft production has been reached, and that while it is hoped to obtain a substantial share of growing civil requirements, " this will not replace the declining military volume." The future market here mainly lies, said Mr. Waring, in technological development and economic production and operation.

The name of Joseph Lucas is more usually associated with the motor and vehicle industries, however, and it was obvious from the chairman's speech that the continuity of the prosperity enjoyed by the group depended to a large extent on the fortunes of the market for motor cars. Net profit for the year ended July 31, 1955, stood at £1,228,831—a rise of only 0·05 per cent. on the previous year's total, while the consolidated surplus before tax and reserve allowances were made actually declined by some 12 per cent. This would at first sight seem to conflict with the record profits enjoyed by some motor companies, but Lucas say that they are keen to keep prices down even at the expense of lowering profit margins. To this end, the company can show a remarkable increase in productivity over the last few years. Since 1948, the labour cost per unit of automobile electrical equipment supplied has been lowered by 20 per cent. although average hourly earnings of the workpeople concerned has actually increased by some 60 per cent. in the same period. But the company share the motor industry's growing concern over rising materials costs, particularly of copper and zinc. Wages have risen by only 5 per cent. since last year, but the price of copper has increased by some 70 per cent., and its supply position is uncertain. In common with the motor industry also, Joseph Lucas (Industries) Limited feel that unless output is increased " there would be the utmost difficulty in keeping down prices to anything like their present level."

How closely the fortunes of Lucas depend upon the continued success of the motor industry is also evident in their concern over German competition. Yet Mr. Waring is at a loss to understand why the Germans should progress so rapidly since, as he points out, British cars can compete favourably both in quality and price with Continental models. He can only point to the better salesmanship and service arrangements evident in the German overseas effort.

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Canada is Vital

British manufacturers have tended to neglect the Canadian market for long enough. While British exports to Canada have recovered from the low levels reached early in 1955, they represent only 8 per cent. of the goods entering Canada from abroad, compared with the pre-war share of 20 per cent. (and a post-war high of 11 per cent.). During the first ten months of 1955 our exports to Canada remained the same as in the corresponding period of last year, despite a 9 per cent. rise in the Canadian gross national product. Meanwhile, Continental competitors have been stepping in, and the United States has also increased its share. Yet Canada says that it wants to " buy British "—and not necessarily from any feeling of sentiment. It is in their own interest to develop their export markets and the United Kingdom is Canada's second largest customer. There are large markets for all types of capital goods—particularly machinery and equipment for the big new mining developments, and naturally the demand for consumer goods is rising consequently. Why then has Britain lost ground in the Canadian market?

It has been suggested that United Kingdom manufacturers are unable to offer short delivery dates due to rising investment demand at home and in other countries. The proximity of the United States is quoted as offering lower transport costs and hence lower prices, even though British manufacturers have been assured that they have nothing to fear in this direction, since United Kingdom prices are often as much as 25 per cent. less than their competitors. Such excuses, however, cannot explain German success. The real answer probably lies in a remark made by Mr. Marc Boyer, a member of the recent mission to Britain from the Canadian metal mining industry. " You cannot sell in Canada from a desk in the United Kingdom. You must be on the ground over there." Mr. Boyer condemned the apparent lack of aggressive selling and recommended British manufacturers to appoint their own representatives and selling organisations in Canada, the warehousing of stocks for immediate dispatch, and the establishment of assembly plants. Certainly, the majority of British concerns who have penetrated the Canadian market on any scale have found the experiment rewarding. Another recent suggestion was that companies should co-operate to reduce the expense, share the risk, and by this means present a wider and more attractive range of goods and thereby secure better representation in Canada, as has been done over the St. Lawrence project.

Opportunities there certainly are. In 1955 the amount spent on construction work on new houses is said to be 200 million dols. higher than last year's total of 4,800 million dols. Output of base metal (copper, nickel and zinc) this year is estimated to be 12 per cent. above the total in 1954, while output of aluminium is increasing steadily. A most significant indicator is electric power. The gross generating capacity of electricity stations is planned to reach 16·6 million kW in 1958 compared with 13·1 million in 1954. These are signs not only of boom but of long-term expansion.

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I.Mech.E. Lubrication Group

Applications to join the new Lubrication Group have been coming in to the Institution of Mechanical Engineers since the formation of the Group was announced on a leaflet enclosed with the December issue of *The Chartered Mechanical Engineer*. By the time this issue of ENGINEERING is published the names of the first members of the Group committee will have been decided by the Council. The first chairman of the committee—Dr. D. Clayton, M.I.Mech.E.—has already been appointed.

A few months ago a number of engineers made tentative plans to form a separate society of locomotive engineers. They envisaged the possibility of affiliation to one of the existing major engineering institutions, as reported in our Weekly Survey columns for September 23, but chose to start with an independent group. The prompt action of the Institution of Mechanical Engineers has, however, led to the proposal for a " splinter society " being abandoned. The new arrangement is undoubtedly the better of the two. But like the British Nuclear Energy Conference (a consortium formed by several institutions) its direction must be in the hands of a broad cross-section of members if it is to prosper. The activity and negotiation which have resulted in the formation of the I.Mech.E. Lubrication Group prompt the question: is there, perhaps, some other specialised activity which needs special attention from any of the engineering institutions? It would be far better to foresee the need, and meet it in good time, than to have to take special emergency action.

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Industry for West Africa

The report of a visit to Nigeria and the Gold Coast published by the Federation of British Industries has come in for a good deal of criticism. The mission looked into the opportunities for British enterprise establishing new industries in the two colonies. Their report, though certainly not optimistic, is at least realistic. Broadly, they counsel a wait-and-see attitude owing to the rapid development of economic nationalism and regional separatism in these territories and they rate the opportunities in the Gold Coast higher than those in Nigeria. They also put the chances of trading opportunities higher than those for industry.

One good feature of the report should be stressed. It puts its finger on the basic limiting factors of industrial development in West Africa. These are shortage of raw materials, lack of electric power, high cost of labour (wages are low, but so is productivity), lack of managerial ability for new projects and shortage of local capital. This is a formidable list and indicates the need for caution in assessing the cost side

of a new venture. The report is equally sound in its emphasis on the tendency of regional separatism to prevent the development of a national market and the opportunities for large-scale production which would follow. The means of developing a large market are few, stereotyped and difficult to mobilise quickly in an area of peasant proprietors with small incomes (small, at least, by European standards). The main outlets are through European trading companies and African traders.

In one important respect, however, the report is open to criticism. While it is true that the rapid political development of these two colonies will not ease the lot of new British ventures in some respects, there is another reason why investment in West Africa is hazardous. The mortality rate of new enterprises in West Africa has always been high and the area has had its share of optimistic, half-boiled projects which have raised high hopes of rapid industrialisation which have never materialised. Experience has shown that most success has attended projects backed by large local resources of capital and management. In consequence, the Government themselves (with some startling exceptions) and the big trading companies have been most successful in developing local industries. This has always raised the cry that the smaller men (and at times the African) have been squeezed out. There may be some truth in this, but the fact is that only those who can afford to lock up capital for some time can usually expect to see results.

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Machine Tool Industry

A very comprehensive survey of the machine tool industry has been prepared by the Noble Lowndes Finance Company, Limited, a firm which specialises in pensions schemes. The value of production in 1954, the survey states, was approximately £66 million of which some £20 million represented exports. This compares with an output of £10·5 million in 1937, although the greater complication and, therefore, rise in prices of machine tools makes comparisons difficult. New orders this year have returned to their peak of 1951, although exports as a proportion of the total have fallen from 33 per cent. to 20 per cent. The volume of new orders exceeded the volume of output in mid-summer, and delivery dates, especially for heavy machines, are now extended. Imports reached very high figures in 1951 and 1952 due to the defence programme, but last year fell to just over £16 million, mostly from the U.S.A., Western Germany and Switzerland.

Expansion is retarded by a general shortage of skilled workers, and most firms are more likely to aim at increasing their own productivity and that of the machine tools they manufacture than to expand their manufacturing facilities. There is said to be a four-year cycle of production in the industry, so that manufacturers tend to undergo periods of little apparent change, and at present the industry may be said to be in a trough of technical evolution. International competition is intense, especially from Western Germany which now has as many machine tool factories as there were in the whole Reich immediately before the war.

Discussing the outlook for investors in the industry, the survey quotes the British Productivity Council Report that the replacement market in the United Kingdom—something over 60,000 machines per annum—should be large enough to absorb the current rate of domestic deliveries for some years to come, but importation will inevitably continue on a large scale, because for many tools Continental suppliers are preferred. The export trade will become increasingly difficult and many British manufacturers are hampered by labour shortage and lack of finance. Expansion, therefore, will be on a more modest scale than in the industries which are customers for machine tools.

The industry consists mainly of small firms, the vast majority of which employ less than 200 workers. Many of the best known names are those of fine, well established private companies, who show every sign of seizing the opportunities which await the technically progressive sections of the industry. To do so, they may well have to adopt the status of public companies, for the extra capital required to expand will be very considerable indeed.

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Canals in the Future?

The old canal system is reaching an impasse. The British Transport Commission has maintained the better routes in fair order, but faces increasing loss as the traffic declines. The narrow boats are too small and accomplish too few ton-miles per hour. But simple abandonment creates difficulties, because of the extensive use of canal water for condensing purposes at power stations, or for agriculture; closure of the narrow-boat system centred in the Midlands would isolate the broad waterways about the estuaries. Moreover, so negative a policy is in strong contrast to the building of large new canals on the Continent in recent years.

The counter proposals of the Inland Waterways Association call for an overruling National Waterways Conservancy to carry out a large but undefined programme of expansion and modernisation, with a view to providing road-traffic relief, water supply and amenity.

As a measure of the scale required for an effective expansion, consider the project for a Grand Contour Canal as outlined in ENGINEERING of December 11, 1953. This proposed one-level canal would extend along a favourable contour from Tyneside to Southampton, linking the main industrial centres for navigation and serving also as a water grid. In the latter function, the delivery would be 2,000 cusecs—enough to irrigate 1,000 square miles of root crops and grassland giving a 20 to 50 per cent. increased yield in most years. But it should also meet mounting demands in public water supply, and do so more rationally than is done by statutory authorities making expensive separate provisions against drought. The proposed 2,000 cusecs is no more than in scale for a planned national water grid—if indeed, it is adequate—but this delivery would require a waterway large enough to float Continental barges of 1,000 tons or so, and such vessels doing long, steady hauls in train would be in scale with the road-traffic relief problem as nothing less could be.

The expected capital cost of the Grand Contour Canal is over £400 million—a financial measure of effective development. This sum is likely to be too heavy for a "Conservancy"; in theory, the fast retreating Transport Commission would manage it better. Alternatively the Canal could be constructed by free enterprise, building up from suitable initiating sections.

Meanwhile the Thames, Severn, and Trent are safe. The Wey Navigation and Basingstoke Canal keep going in private ownership. The Bridgewater Canal has increased its traffic under the on-the-spot control of the Manchester Ship Canal Company. Local enthusiasm has restored the Lower Avon. Perhaps the canals impasse will be resolved in default of State action rather than by such a development.

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Essential Thoughts on Fuel

Britain was a big net importer of coal in 1955. Its import bill for coal and oil at £180 million for the first eight months of the year (after allowing for exports) was over a quarter of the total visible trade deficit. Yet many industrialists seem reluctant to realise the importance of fuel efficiency. They say that their fuel costs are only a very small proportion of total costs and as such are not worth worrying about; their managements are not anxious to be disturbed by the dislocation arising out of installing new equipment; they predict (unwisely) that atomic power for all is just around the corner; they point to the record level of coal stocks.

A paper read by Dr. G. H. Daniels, of the Ministry of Fuel and Power, to the Institution of Production Engineers recently contains several timely warnings. The main point is that prospects for coal and oil production are not as bright as was thought even five years ago. Easily mined coal has long been worked out. Coal will continue to be scarce and will become dearer, for even if mining machinery is introduced on a large scale—and the structure of British mines is an important limiting factor—capital cost per ton will rise accordingly. Nor does Dr. Daniels hold out any great hope for a large-scale switch to oil. He maintains that the fall in the real price of oil has now been halted. It will become dearer to extract, and "the remaining reserves of oil are much less than those of coal" (which is, perhaps, a better propaganda point than a demonstrable truth). In fact, "the prospects for continued growth in the prosperity of the population of this and other countries would be brutally short but for the promise of nuclear energy." It is unwise, however, to expect production of energy from nuclear fission on any scale until at least 1965, and even then it has been estimated by the Central Electricity Authority that nuclear energy will contribute at most only 7 per cent. to the nation's fuel needs. Not until 1970 at least will the pressure on coal be eased by nuclear power.

A few of the ways in which the campaign could be implemented were suggested by Mr. L. A. W. Jenkins, Director of the National Industrial Fuel Efficiency Service, in a paper, "Fuel Economy and Its Implications for Management," presented to the British Institute of Management. Considering fuel efficiency a "stark necessity," Mr. Jenkins estimated that up to 20 per cent. of the coal bill could be eliminated without difficulty.

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Builder of Prototypes

Modern ideas on "big business" favour the theory that a small firm must expand if it is not to risk being put out of business. It would not be difficult to argue the case for keeping a small firm small, thereby preserving those near-personal qualities which are denied to the large firms—qualities which are appreciated by customers from one generation to another.

Such a firm is George Wailes and Company, Limited, founded a hundred years ago by a young man of that name at the age of 21. With the backing of his father-in-law he took over two engineering firms, one at Stroud, Gloucestershire, and the other in London. For some years he lived at Stroud and spent three days each week at London, travelling by train, but when his first two children died in infancy (due, it is believed, to the bad water at Stroud) he moved to London, leaving the other works in the care of his brother. Finding the arrangement unsatisfactory he sold the Stroud works. George's eldest son Herbert was his father's partner from 1881 to 1904 but left in the latter year and subsequently became an eminent marine biologist. Another son, Reginald Percy, who joined the firm in 1889 as an apprentice, went through a difficult period when his father retired in 1906. To realise the property and plant he was obliged to borrow capital in order to buy in such plant as he could afford at the auction sale. For a time he ran the business in temporary premises but eventually he moved to the present works at 386-388 Euston-road, London. In 1924 he was joined by his elder son, Mr. Rex Wailes, now managing director of the firm and widely known for his work on the history of windmills.

Though the business has never grown large it can take pride in having constructed the prototypes of machines which have since become famous. It built the first successful versions of the Akroyd Stuart engine, a carbon-paper coating machine, and a flexible-tube producing machine. It can count, too, experimental work for Siemens and Ferranti among the contributions that, perhaps, only such a firm could make to the common weal of engineering.

CLIMBERS' OXYGEN BREATHING APPARATUS IMPROVED

FROM EVEREST TO KANGCHENJUNGA

On May 25 last a British mountaineering expedition sponsored jointly by the Royal Geographical Society and the Alpine Club, and led by Mr. Charles Evans, one of the Everest team, ascended to within 5 ft. of the summit of Kangchenjunga —the third highest mountain in the world (28,146 ft.) and considered by Sir John Hunt to present severer technical climbing problems and dangers than Everest itself. Kangchenjunga is believed by the Sikkimese to be a sacred mountain, and the expedition had undertaken not to desecrate the neighbourhood of the summit; for that reason they refrained from setting foot on the peak.

The whole of the oxygen equipment for the 1955 Kangchenjunga expedition was supplied by Normalair Limited, Yeovil, in co-operation with the British Oxygen Company, Limited, who were responsible for charging the high-pressure cylinders made for the expedition by the Chesterfield Tube Company Limited. Other equipment sub-contractors included Gatehouse and Son, Silver-street, Yeovil, who supplied the pack harness; and David Harcourt Limited, who supplied pressure gauges.

The equipment comprised 12 open-circuit breathing sets, two experimental closed-circuit breathing sets, 62 oxygen cylinders, sleeping masks and valves, and a B.O.C. Boyle's anaesthetic apparatus modified by Normalair to reduce its weight. This set, in the event, was not taken on the ascent because of transport difficulties.

The lessons learnt on the 1953 Everest expedition led to modifications directed to weight reduction and to simplifying the operation of the sets. In the Everest expedition light-alloy oxygen cylinders were used, designed for a maximum working pressure of 3,500 lb. per square inch, with a capacity of 800 litres each. Three bottles supplying one breathing set had a total weight of 40 lb.

HIGHER STRENGTH-TO-WEIGHT RATIO

In the Kangchenjunga expedition cylinders of a higher strength-to-weight ratio were used, supplied by the Chesterfield Tube Company, Limited. They were of the seamless type in a hardened and tempered nickel-chromium-molybdenum steel, wound with high-tensile piano wire under tension.

The overall dimensions of the larger cylinders were 6·8 in. outside diameter by 15 in. overall length, and of the smaller cylinders, 6 in. outside diameter by 10·5 in. overall length. The working pressure of the cylinders was 3,750 lb. per square inch, giving oxygen capacities for the two cylinders of 1,670 litres and 800 litres respectively, the corresponding "water capacities" being about 13 lb. 14 oz. and 6 lb. 11 oz. respectively. For the larger cylinders the average weight empty was 11 lb. 4 oz. and for the smaller 6 lb. 3 oz. Both types of cylinder could be used either on single-cylinder or twin-cylinder breathing sets; using two of the larger cylinders, a complete set —3,200 litres—weighed 39 lb., i.e. less than the 2,400-litre Everest set.

All the cylinders were hydraulically tested to an internal pressure of 5,625 lb. per square inch—1·5 times the working pressure. Hydraulic bursting tests were also carried out on representative cylinders from each batch. The test cylinders failed at pressures of the order of 9,000 lb. per square inch.

Another test designed to simulate possible working conditions consisted of dropping a fully-charged cylinder 12 ft. on to the "corner" of a piece of angle iron resting on a concrete floor. This test was performed on cylinders of both sizes and in each case only a slight dent was produced which had no detrimental effect on the efficiency of the cylinder.

The cylinders were painted in distinctive colours, bright yellow for the large type and marine blue for the smaller pattern. These colours were chosen so that the cylinders could be readily picked out against snow backgrounds and at the same time the colours had relatively low thermal absorptive factors, thus to some extent minimising the effect of the heat of the sun's rays on the pressure of the oxygen inside the cylinders.

To appreciate the way in which the climber's task of regulating his equipment was simplified in the Kangchenjunga sets, it is desirable to recall briefly the arrangement adopted in the Everest open-circuit sets. The three bottles were harnessed to a metal framework on the climber's back. Each bottle had its own supply shut-off valve, pressure gauge, and reducing valve. A flexible pipe from each pressure reducer led to a manifold which incorporated two sockets, to which a single bayonet plug from the economiser could be plugged in, giving a choice of two fixed flow rates. It will be appreciated therefore that the climber could neither check his own oxygen supply nor adjust his flow rate while wearing his apparatus.

FLOW REGULATION BY CLIMBER SIMPLIFIED

In the Kangchenjunga open-circuit sets, each cylinder was fitted with a stop valve only. A high-pressure hose connected the cylinder to a pressure gauge and reducing valve mounted on the right-hand side of the carrier framework, easily visible to the climber so that he had a constant check on his oxygen supply throughout the climb. A six-position flow selector was built in to the pressure reducer which the climber himself could adjust. To facilitate regulation of the supply, colour-coded cards tabulating endurance against pressure-gauge reading for each flow rate were supplied to the climbers—yellow cards for the large cylinders and blue cards for the small ones. The replacement of three separate pressure gauges and reducing valves by a single unit, as well as simplifying the set's operation, contributed usefully to weight saving.

From the reducing valve the oxygen, now at a nominal pressure of 40 lb. per square inch, flowed continuously to the economiser, which is seen in Fig. 1 between the two oxygen cylinders. The action of the economiser, which allows oxygen to be fed to the climber only on inspiring, may be understood from Fig. 2. As the climber exhales, oxygen flowing into the flexible bag of the economiser moves a spring-loaded hinged flap and causes a trip valve to close at the entry to the breathing tube. Exhaled air escapes through valves in the side of the mask. On inspiration, the depression in the mask opens

Fig. 1 A twin-cylinder open-circuit set, with a 3,200-litres capacity, weighed 39 lb.—a little less than the 2,400-litre sets used on Everest in 1953.

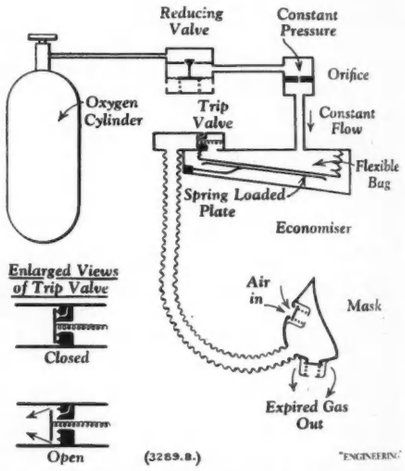

Fig. 2 Principle of the economiser, which ensures a concentrated oxygen supply at the beginning of inspiration.

Fig. 3 Two or three climbers were supplied from one oxygen breathing set when sleeping.

the trip valve and brings the spring-loaded flap on to the breathing bag, forcing oxygen rapidly into the breathing pipe. Subsequently, spring-loaded valves in the mask open to allow the entry of atmospheric air. Thus, the climber gets a small concentrated supply of 100 per cent. oxygen at the beginning of inspiration which penetrates well into the lungs, followed by a supply of excess air—a more effective method of feeding the oxygen than distributing it uniformly throughout inspiration. As in the Everest equipment, a rubber shroud over the outside of the mask protects the inspiration valves from ice formation. The valves themselves have been modified to reduce pressure losses.

SLEEPING SETS

One of the lessons learnt during the Everest expedition was the enormous value of using oxygen while sleeping at high altitudes. Accordingly sleeping sets were provided (as shown in Fig. 3) and were much appreciated. Utilising one main breathing-set oxygen supply between two or three men, each climber's set comprised a light-weight mask adapted from a standard aircraft-type mask, with a flexible bag forming a crude type of economiser, and a tube connecting the mask to a two or three-way T-piece, the single leg of which was connected by a bayonet fitting to the flow selector of the main breathing set.

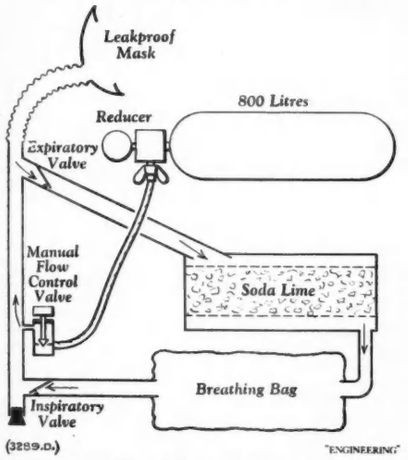

Fig. 4 Principle of the 1953 Bourdillon closed-circuit oxygen set.

Fig. 5 The 1955 closed-circuit set had a six-position flow selector in place of the continuously-adjustable manual flow valve of the 1953 set, and the valves were relocated together in a rubber Y-piece assembly.

During exhalation, the sleeper expires partly into the flexible bag and partly through a hole in the mask, while oxygen flows continuously into the bag. On inspiring, the sleeper takes in the mixture of oxygen, air and CO_2 in the bag plus a further supply of air through the mask aperture. The effect of re-breathing is to increase the rate of respiration and this is believed to be beneficial.

CLOSED-CIRCUIT SETS : SIX FLOW RATES

The two closed-circuit oxygen sets supplied by Normalair were developed from the Bourdillon closed-circuit apparatus used in the Everest expdition, with which some remarkably high performances were obtained. The Bourdillon set, the principle of which is illustrated in Fig. 4, comprised an 800 litre bottle with pressure-reducing valve from which oxygen was fed to an infinitely-variable manual flow control valve regulated by the climber.

A single tube from the leak-proof face mask divided to form inspiration and expiration tubes with non-return valves located as shown in Fig. 4. Exhaled air passes through the expiratory valve through a soda-lime canister, in which the carbon dioxide content (5 per cent. of the total) is absorbed, thence into the breathing bag where it mixes with the oxygen entering from the flow valve. The latter is so adjusted that the bag, which has a much greater capacity than the climber's lungs, is never either fully inflated or deflated.

In the Normalair development (Fig. 5), the manually-adjusted flow valve was replaced by a six-position flow selector specially adapted for closed-circuit use, to cover the likely range of oxygen absorption rate by climbers at high altitudes, thus easing the task of regulation for the climber, whose powers of concentration are adversely affected by altitude. The valves of the Bourdillon set were re-located close together in an all-rubber Y-piece assembly. In the event of ice formation, the whole flexible assembly can be " kneaded " to break the ice. The breathing bag is protected by Fibreglass insulation, and the soda-lime canister has a temporary insulation which can be ripped off when the soda-lime heats up under the exothermic action.

In comparison with the open-circuit set, the soda-lime canister imposes a weight penalty; with an 800 litre bottle the closed-circuit set weighs 28¼ lb. whereas a similar-capacity open-circuit set weighs only 16 lb. Another characteristic of the closed-circuit type of apparatus which may impose some discomfort on the climber is the fact that, owing to the exothermic action of carbon dioxide absorption by the soda-lime, the heat balance varies during the climb. For these reasons open-circuit sets only were used on the main climbs.

The Bourdillon type of set has, however, great advantages in that no oxygen is wasted, whereas in the open-circuit type it is inevitable that 20 per cent. of the oxygen escapes to atmosphere, and that the climber receives pure oxygen undiluted by nitrogen. It is this factor which has led to the high performances recorded by climbers using closed-circuit oxygen apparatus. In the Everest expedition, it may be recalled, Hillary and Tenzing, using open-circuit sets, climbed in a prepared " track " from 25,850 ft. to 27,300 ft. at a rate of 630 ft. per hour. Using closed-circuit rebreathing sets, Bourdillon and Evans, making their own track, covered the same vertical distance at a rate of 930 ft. per hour.

Obituary

SIR SAMUEL ROBERTS, BT.

Industrialist and Parliamentarian

The death of Sir Samuel Roberts, Bt., which occurred suddenly in London on December 13, removes a well-known figure from business circles in South Yorkshire and the Midlands. Sir Samuel, who was the son of the first baronet, was born in Sheffield in 1882 and retired at the end of last year after occupying the chairmanship of Newton Chambers and Company, Limited, Thorncliffe, near Sheffield, for upwards of 20 years. His successor was his son, Mr. P. G. Roberts, M.P., who will become the third baronet and who also succeeded his father as chairman of the Wellman Smith Owen Engineering Corporation, Limited.

Sir Samuel was educated at Harrow and Trinity College, Cambridge, and became a solicitor in 1906. He was elected to the Sheffield City Council in 1910 and was Lord Mayor of the City from 1919-20, twenty years after his father had occupied the same position. He sat in Parliament as Conservative Member for Hereford from 1921 until 1929 and for the Ecclesall Division of Sheffield from 1929 until 1935. It is of interest to note that his son is now M.P. for the Heeley Division of Sheffield, which includes a portion of the former Ecclesall Division.

Sir Samuel, who was a descendant of Robert Sorsby, the first Master Cutler of 1624, was installed in that position in 1935 and his son is due to be Master Cutler next year.

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We regret also to record the death of:

MR. ALBERT MYCOE, of Victoria Park, Manchester, in hospital, on December 4. He was manager of the traffic department of the Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17, a position he had occupied since 1920. Starting his career as a clerk with the Midland Railway, he joined the staff of the Metropolitan-Vickers Co. in 1907 as chief railway clerk. Mr. Mycoe played an important part in the design and construction of special railway and road vehicles for the conveyance of heavy stators and transformers.

Letters to the Editor

THE FORESEEABLE FUTURE

" Guesses " of a Physicist

SIR, Your review of *The Foreseeable Future* in your issue of November 25 certainly showed what an illuminating book Sir George Thomson has written; but it naturally could not comment upon all Sir George's wide-ranging speculations. Yet doubtless he hoped that someone would seize upon a few of the specific ideas that he so engagingly played with. Why should not engineers do so? Perhaps, in their own field, their guesses might be as good as the physicist's.

There is, for example, a forecast that new materials will give us lighter and more flexible suspension bridges. But do we really want more flexible bridges? Did not the Tacoma Narrows bridge collapse just because it was not stiff enough? Then, marine architects could examine the proposal to transport goods across the world in fast submarine ships. They could estimate the cost of giving a pressure hull and vast water-ballast tanks to underwater cargo carriers. There would be interesting problems in designing streamlined cargo hatches and cargo-handling gear. Civil engineers would be struck by the author's rough calculation suggesting that the cost of conveying purified sea-water for irrigation need not be prohibitive. Their own more detailed calculations might give a different result, especially if the land to be cultivated lay many hundreds of feet above sea-level.

But some of Sir George's sayings can hardly be challenged. Here is one: " People's minds tend to fall into one of two classes, the humanistic —interested mostly in people and words ; and the scientific and engineering—interested mostly in things and ideas." Will engineers ever succeed in building bridges that will unite these two groups ?

Yours faithfully,
HERBERT ADDISON.

56 Richmond-hill,
Richmond,
Surrey.
December 5, 1955.

PERSONAL

LORD CROOK, J.P., and MR. J. C. POOLE, C.B.E., M.C., have been reappointed chairman and vice-chairman, respectively, of the National Dock Labour Board for the period January 1 to December 31, 1956.

Following the retirement of SIR IAN PARKIN, C.B.E., owing to ill-health, MR. M. R. HADDOCK, O.B.E., has been appointed general manager and secretary of the National Dock Labour Board. Mr. Haddock was formerly assistant general manager and assistant secretary of the Board, to which position he was appointed in September, 1952.

MR. R. DRINKWATER has been appointed turbine specialist engineer at the Brush Electrical Engineering Co. Ltd., Loughborough, in succession to MR. R. D. TAYLOR, who is now the company's London branch manager.

MR. W. T. O'DEA, B.Sc., M.I.E.E., keeper of the department of aeronautics and sailing ships in the Science Museum, South Kensington, London, S.W.7, has been seconded to the Technical Assistance Branch of UNESCO to take up an appointment for three months in Ceylon as adviser on the establishment of a schools science museum service.

The Distington Engineering Co. Ltd. (branch of the United Steel Companies Ltd.) announce that MR. T. S. KILPATRICK will relinquish his duties as commercial manager of the company on his appointment as deputy general manager of the Workington Iron and Steel Co. on January 1, 1956. He will remain a director of the Distington Co. On the same date, MR. A. E. BELL, sales manager (engineering), is appointed general sales manager and MR. T. WINTRUP, contracts manager, will become sales manager (engineering).

The Appleby-Frodingham Steel Co., Scunthorpe (branch of the United Steel Companies Ltd.), announce that, as from January 1, 1956, MR. W. GEARY, works manager (services) will relinquish his present responsibilities and will take over special duties for the general works manager in connection with management studies and statistics. MR. T. P. LLOYD, works manager (steel) will take over the duties of works manager (services). MR. W. JACKSON, melting shops manager, will become works manager (steel).

MR. DEREK BRADE has been appointed chief flight development engineer to Folland Aircraft Ltd., Hamble, Southampton.

MR. W. F. GRIFFITHS, B.Sc., A.M.I.E.E., has been seconded by Crompton Parkinson Ltd., Crompton House, Aldwych, London, W.C.2, to take over, from Mr. C. J. CLOSE, the position of general manager of Crompton Parkinson (South Africa) Pty. Ltd., Johannesburg. Mr. Close who has been with Crompton Parkinson (South Africa) Pty. for nearly 25 years, is leaving at the end of this month to take up an appointment at Kitwe, Rhodesia.

MR. W. R. BISHOP has accepted an invitation to join the board of J. A. Prestwich Industries Ltd., with effect from December 8. He joined the firm as sales manager on July 1, 1953.

MR. R. K. DEANE has been appointed production controller to R. B. Pullin & Co. Ltd., Phoenix Works, Great West-road, Brentford, Middlesex. MR. H. R. BOTTING has been made chief buyer.

MR. A. G. PEACOCK, B.Sc., A.R.I.C., A.Inst.P., has been elected chairman of the electrical and electronics section of the Scientific Instrument Manufacturers' Association, 20 Queen Anne-street, London, W.1, in succession to MR. P. GOUDIME, M.A. The vice-chairmen are MR. R. Y. PARRY and MR. L. A. WOODHEAD.

THE HON. L. O. RUSSELL is resigning the directorship of the British Institute of Management, 8 Hill-street, London, W.1.

MR. J. G. YOUNG has been awarded the Sir William J. Larke Medal for 1955 of the Institute of Welding, 2 Buckingham Palace-gardens, Buckingham Palace-road, London, S.W.1, for his paper, "Construction of the All-Welded Twin-Screw Auxiliary Motor Yacht, Morag Mohr."

MR. SAM BLACK has been appointed head of the publicity department of the British Electrical and Allied Manufacturers' Association, 36 and 38 Kingsway, London, W.C.2.

MR. S. G. COPPING has been appointed London area sales representative by Electropower Gears Ltd., Kingsbury Works, Kingsbury-road, London, N.W.9. Mr. Copping was previously London sales representative for the Anchor Chain Co.

MR. G. BREWER has been appointed manager of the cast-iron and bronze foundry of Sheepbridge Alloy Castings Ltd., a subsidiary company of Sheepbridge Engineering Ltd. MR. D. BERRIDGE has now taken up his appointment as sales manager to the company; MR. E. G. SCRANNAGE has been appointed methods engineer, while MR. S. MARTON, B.Met.(Sheffield), is occupying a new research post, where he will be in charge of the development of a process for the continuous casting of bronze tubes.

* * *

COMMERCIAL

C. C. WAKEFIELD & CO. LTD., 46 Grosvenor-street, London, W.1, parent company of the Wakefield group, announce that their principal subsidiary company, W. B. DICK & CO. LTD., is to be reconstituted, as from January 1, 1956, under the name of WAKEFIELD-DICK INDUSTRIAL OILS LTD. The new company will also embrace the functions of the former WAKEFIELD-DICK INDUSTRIAL LUBRICANTS DIVISION of C. C. Wakefield & Co., and will operate solely in the United Kingdom, all export business of the group being conducted by the overseas division of the parent company. The board of Wakefield-Dick Industrial Oils will comprise, MR. L. W. FARROW C.B.E., (chairman), MR. L. M. BROADWAY, MR. W. F. LIST, MR. A. J. SEAR, MR. J. A. V. WATSON, O.B.E., MR. L. G. PACKHAM, MR. R. J. TURNER, MR. C. F. DENNIS, MR. R. F. BALDWIN, MR. J. S. ROLPH, MR. G. H. THORNLEY and MR. R. LAYET. The secretary will be MR. L. J. WINDRIDGE and the registered office will be at 67 Grosvenor-street, W.1.

The assets of two light engineering works have been acquired by CHARLES COLSTON LTD., 3 Mill-street, London, W.1, namely, TALLENT (AYCLIFFE) LTD., in County Durham, and SMITH-RICHARDS, LTD., High Wycombe, Buckinghamshire. MR. J. P. FORD, managing director of Charles Colston Ltd., has been appointed chairman of the two new subsidiary companies.

SHEEPBRIDGE ENGINEERING LTD. have acquired the whole of the issued share capital of W. E. BRAY & CO. LTD., manufacturers of the HYDRALOADER, Feltham, Middlesex. The name of HAROLD ANDREWS GRINDING CO. LTD., manufacturers of cylinder liners and of FLOCAST continuously-cast iron bar, has been changed to HAROLD ANDREWS SHEEPBRIDGE LTD. This is consequent upon the firm becoming a subsidiary company of SHEEPBRIDGE ENGINEERING LTD., Chesterfield. The company's address remains: Manor Lane, Halesowen, Worcestershire.

Under an agreement concluded with the J. M. LEHMANN CO. INC., Lyndhurst, New Jersey, U.S.A., the Lehmann G31-V ink and paint roller mill is now being manufactured by HENRY SIMON LTD., Cheadle Heath, Stockport.

In view of inquiries received following the announcement, made in this column on September 2, page 295, of a long-term agreement between HENRY PELS & CO., LTD., 32-38 Osnaburgh-street, London, N.W.1, and INDUSTRIE-WERKE KARLSRUHE A.G., Karlsruhe, Henry Pels wish to make it clear that there is no financial connection between the two companies and that Industrie-Werke Karlsruhe are the sole owners of the original German Pels Co.

PLANNAIR LTD., Leatherhead, Surrey, inform us that the PESCO division of the BORG WARNER CORPORATION have recently completed negotiations for the manufacture of Plannair axial-flow blowers, under licence, in the United States.

WEST INSTRUMENT LTD., 1 Newman-street, London, W.1, are now producing a new stepless temperature controller for use with plastic machinery, electric furnaces, kilns or other electric loads. The firm add that their telephone number has been changed to MUSeum 6663.

THE DIESEL ENGINE USERS ASSOCIATION have now changed their name to the DIESEL ENGINEERS and USERS ASSOCIATION, 56 Victoria-street, London, S.W.1.

J. H. FENNER & CO. LTD., Hull, have opened a new branch for mechanical-power-transmission equipment at 50 Southgate-street, Leicester. The regional manager is MR. S. PARKER and MR. R. H. H. DYER is responsible for the Leicester area.

WINSTON ELECTRONICS, LTD., Shepperton, Middlesex, announce that on and after January 1, 1956, their telegraphic and cable address will be changed from "Control Shepperton" to "Winston Shepperton."

THE GENERAL ELECTRIC RESEARCH LABORATORY, Schenectady, New York, U.S.A., has established a European office and appointed DR. G. J. SZASZ to be its chief scientific representative abroad. For the present, Dr. Szasz will maintain an office with International General Electric Ltd., Crown House, Aldwych, London, W.C.2.

CONTRACTS

Dirt Preparation Plant for Colliery. A new dirt preparation plant for Penallta Colliery, Wales, is to be built for the National Coal Board by the Engineering Division of KEIR and CAWDER LTD., Bishopbriggs, Glasgow. The plant is due for delivery in about a year's time. When completed, rubbish will be brought from the pit by means of tubs, gravitating towards a rotary tub tippler and the material discharged to a shaker feeder controlling the flow to a picking table. Coal and timber are to be manually extracted from the picking table and placed in chutes delivering to a conveyor. From there it is conveyed to a 20 ton hopper. Picked rubbish is discharged from the picking table to a vibrating bar grizzly screen for grading.

Cement-Making Equipment. A contract valued at £750,000 for the supply of two rotary-kiln units and other equipment for the production of 600 tons of Portland cement a day, to be erected at Doroud, a village some 250 miles south-west of Tehran, the capital of Persia, has been obtained by EDGAR ALLEN AND CO. LTD., Imperial Steel Works, Sheffield, 9. The delivery of the plant is to be completed in two years. The two kilns are each 330 ft. long, by 9 ft. and 10 ft. 6 in. in diameter and the other equipment includes a primary crusher, wash mills and tube mills for raw and finished materials.

Air Liners. Continental Air Lines Inc., Denver, U.S.A., have placed an order for 12 Viscount propeller-turbine airliners with VICKERS-ARMSTRONGS (AIRCRAFT) LTD. The aircraft are of a new type, the 810D, which in its developed form will cruise at 400 miles an hour. At first the Continental Lines' Viscounts, which will carry 52 passengers in two-and-two abreast seating, will cruise at over 360 miles an hour. Within a year of delivery, however, more powerful Dart engines, made by ROLLS-ROYCE LTD., will be installed to raise the cruising speed to 400 m.p.h. Deliveries of the aircraft will commence in March, 1958. They will be introduced into service in July, 1958, and deliveries will be completed in September.

Aircraft. A second order from the Ministry of Supply for Sea Devon C. Mk. 20 aircraft, for use by the Royal Navy, has been received by the DE HAVILLAND AIRCRAFT, ENGINE AND PROPELLER COMPANIES. The new order is for three aircraft and these are in addition to the ten SEA DEVONS already delivered to the Royal Navy in the Spring of this year. These aircraft constitute the naval version of the Dove light civil transport which is in commercial and executive service in nearly 40 countries. It is powered by two de Havilland GIPSY QUEEN 70 Mk. 2 engines, each of 380 b.h.p., driving de Havilland 1000-size three-bladed constant-speed feathering propellers.

Another order is for a de Havilland HERON and this, for the 100th of its type, was placed by the Shell Petroleum Co. Ltd. The aircraft is powered by four de Havilland Gipsy Queen 30 Mk. 2 engines, each of 250 b.h.p., driving de Havilland 1000-size two-bladed constant-speed propellers.

Multi-Channel Radio System. A contract for a multi-channel radio telephone/telegraph system, valued at 1 million dols., has been placed with MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex, by the Government of Ecuador. The order includes the supply of radio, carrier-telephone, voice-frequency telegraph and teleprinter equipment, as well as complete power plants, towers, aerials and buildings. The proposed multi-channel radio system will link a number of the more important towns and cities in Ecuador. It will cover a total distance of 265 miles, running southwards from the capital city of Quito, through the important rail point of Riobamba, to the country's principal commercial city and port of Guayaquil.

The carrier telephone equipment is to be manufactured by the AUTOMATIC TELEPHONE & ELECTRIC CO. LTD., Liverpool, 7; the voice-frequency telegraph equipment by the TELEPHONE MANUFACTURING CO. LTD., Orpington, Kent; the power equipment by J. & H. MCLAREN LTD., Leeds, 10; and the teleprinters by CREED & CO. LTD., Croydon, Surrey.

Cement Works Extensions. The Chinnor Cement and Lime Co. Ltd. have placed a contract for extensions to their plant in Oxfordshire with VICKERS-ARMSTRONGS (ENGINEERS) LTD. They will be the main contractors for the entire new plant, including cement-making machinery, civil engineering, structural steelwork and electrical control gear. The new plant will increase the output at Chinnor by at least 100,000 tons a year.

CAST IRON WATERWHEELS IN THE EIGHTEENTH CENTURY

Mr. Paul N. Wilson, D.S.C., M.A., M.I.C.E., M.I.Mech.E., said in his paper "The Waterwheels of John Smeaton," read to the Newcomen Society on December 14, that John Smeaton (1724-92) was one of the greatest engineers of the Eighteenth Century. He was better known as a civil than as a mechanical engineer, his most famous work being Eddystone lighthouse, but he also improved the design and construction of waterwheels blowing engines, and the Newcomen engine. Much of Mr. Wilson's information was obtained from the Smeaton drawings preserved in the library of the Royal Society.

Water power was becoming very important when Smeaton began to practise, and he realised that a lot of the available power was being used inefficiently. There were conflicting opinions at the time about the efficiency of various types of waterwheel, and Smeaton, at the age of 27, carried out experiments with scale models in an effort to settle the question. His apparatus was small, but he obtained consistent results from it, and established a maximum overall efficiency of about 22 per cent. from the undershot waterwheel and about 63 per cent. from the overshot wheel. For obvious reasons Smeaton did not use the undershot wheel if he could avoid it, and in fact only one is recorded as having been designed by him. This was the 32 ft. diameter wheel installed at London Bridge Waterworks in 1768. Overshot wheels were favoured by Smeaton for all installations where the site conditions were suitable, and he designed and built a number in various parts of the country.

PROBLEMS OF A NEW MATERIAL

Smeaton is well known for his development of the use of cast iron in machinery, including waterwheels. He was consultant to Carron Ironworks for a number of years, and this association probably encouraged him to experiment. Wakefield Mill, built in 1754, was one of the first Smeaton mills to have some parts in cast iron, and in 1769 he fitted a cast-iron shaft to the waterwheel of Carron No. 1 furnace blowing engine, which had broken its wooden shaft. Other installations followed, though this new method of construction was not without its problems, and breakages were not infrequent.

Smeaton designed waterwheels for a variety of purposes, including pumping, mills of many different types, ironworks and forges. Of his purely industrial concerns Carron Ironworks were the most important. The works were established in 1760, and Smeaton appears to have been called in as a consultant in 1764 to consider improvements to No. 1 furnace blowing engine. Later, he designed the wheels and machinery for No. 2 furnace engine, gun and cylinder boring mill, and other wheels for working rolls, crushing mills, grinding wheels and hammers. Water shortage was a problem, and every available inch of fall was used, the wheels being designed with great care. Smeaton also designed several dams for Carron, and built a "returning engine" to pump back tail water in dry weather.

Mr. Wilson summed up Smeaton's work by saying that it marked the conclusion of eighteen centuries of wooden waterwheel construction. With modifications and improvements he advanced almost to the limit of power which could be generated and transmitted from wheels built almost wholly of wood. Very soon after Smeaton's death revolutionary improvements in design of waterwheels took place. The most important of these were: all-metal construction, taking the drive from the wheel shrouds instead of the shaft, ventilated buckets on high breast wheels, and Rennie's shutter, which admitted the water over the top in a thin stream, so enabling the maximum use to be made of the available head.

MERCURY HOUSE

New London Headquarters of Cable and Wireless

The continued expansion of the London Telegraph Station of the Post Office at premises jointly occupied by them and Cable and Wireless, Limited, at Electra House, Victoria-embankment, has now necessitated the removal of the latter organisation to a new building at 110 Theobalds-road, London, W.C.1. This new building, which was formally opened by Lord Reith, chairman of the Colonial Development Fund, on December 20 and is to be known as Mercury House, is a reinforced-concrete structure faced with Portland stone and covers about half an acre. The accommodation is arranged in a basement, ground floor and eight upper floors, above which is a penthouse containing the lift machinery, water tanks and air exchange equipment. Nearly 89,000 sq. ft. of working space is available, the offices and departments being generally separated by permanent partitions, although metal glazing is employed where extra light is necessary.

A TELEGRAPH MUSEUM

An interesting feature on the eighth floor is a museum the exhibits in which include a section of the first Atlantic cable, laid in 1858 under the direction of Sir Charles Bright, chief engineer of the Atlantic Telegraph Company. The company's letter book for 1857, when the attempt was first made to span the Atlantic, and a private letter book of Brights are also on view, as well as a number of books on electricity and magnetism from his library. In the entrance hall, glass panels, designed by Mr. John Hutton, depict the world-wide nature of the company's activities.

The services in Mercury House include a pair of automatic homing lifts, with a speed of 300 ft. per minute, in each wing, as well as a goods lift and a hoist serving the unloading bay. The lighting is generally by filament lamps, although fluorescent lamps are installed in the drawing offices and other special positions. The main power cabling is of the Pyrotenax type, the distribution circuits being insulated with polyvinylchloride. In large areas these are contained in the screed covering the floors, the connections being made to the desks through outlets spaced 5 ft. 6 in. apart. An electricity supply is obtained from the public mains through a transformer and switch rooms.

Heating is generally effected by low-pressure hot water in conjunction with Vectair radiators. In the entrance hall, however, copper circulating pipes, buried in the floor, and convector heaters at high level over the doors to the lift lobbies are employed. Ceiling heating is used in the directors' suite. An air exchange system which maintains a slight pressure is installed in the refectory, directors' luncheon room and kitchens. A 200 line automatic telephone system is provided for internal communication and the building is linked to the Post Office system by 20 exchange lines and 200 extensions. There are also connections through private lines to the Post Office's London Telegraph Station by a facsimile transmitter, reception being effected by a Creed teleprinter.

The first floor and part of the ground floor and basement of Mercury House will be occupied in the New Year by the Telegraph Construction and Maintenance Company, Limited, and its subsidiaries. Accommodation will also be provided for the head office of Submarine Cables, Limited.

The new building was designed by Mr. S. Gordon Jeeves, in conjunction with Mr. H. C. Uptors, the main contractors being Sir Robert McAlpine and Sons, Limited.

* * *

PUTTING OUT OIL FIRES WITH AIR

Removing Heat by Agitation

Until recently only an incendiary would have recommended using air or kerosine to extinguish a fire, but experiments carried out by Socony Mobil Oil Company Incorporated of New York during the last few years have shown that this is not so absurd as it seems. In "Beneath the Flames," a 20 minute colour film, this paradox is explained. The film describes a method of extinguishing oil tank fires, known as "air agitation" which has been developed by the company, and convincingly demonstrates its effectiveness.

The method is based on the principle that an inflammable liquid can only burn when the flames are fed by vapours rising from it mixed with oxygen in a burnable ratio. When this burnable ratio no longer exists, the flames cannot be fed and the fire dies; alternatively, when the rate at which the air and vapour mix diminishes the fire starves and the heat intensity is reduced accordingly. In addition, the rate of vapourisation depends on the temperature of the liquid surface.

At a routine fire control demonstration of this principle in the United States it was discovered by chance that the burning surface of a pail of kerosine could be cooled, vapours reduced and the fire extinguished not merely by a conventional cooling agent, such as ice, but equally well by unheated kerosine itself. Further tests showed that by blowing air into the bottom of the pail, cooler kerosine could be pushed from the bottom to the top, and the fire put out, but this time it was the kerosine already in the pail that had extinguished the fire.

A special group conducted tests on a variety of oil products in arger and larger tanks. Finally, in probably the biggest test fire ever made, a tank containing two million gallons of domestic heating oil was set on fire; flames rose 50 ft. into the air. Compressed air was passed into the bottom of the tank and in less than two minutes the fire was out, killed by agitation.

The film shows the development of the air-agitation method of oil-fire control and its application to various inflammable liquids. Not only does it give convincing proof of its efficacy in extinguishing or reducing fires in less time and at much less cost than previously possible, but it shows that by preventing or breaking up the heat wave in low-flash point crude oil, the fire may be more easily approached and extinguished by foam or water; "slop-over" can also be avoided. It also makes clear that in general the use of nitrogen or carbon dioxide instead of air gives no marked improvement.

Copies of the film may be borrowed from the Information Section, Mobil Oil Company, Limited, Caxton House, Tothill-street, Westminster, S.W.1.

* * *

LONGER LIFE FOR ELIZABETHANS' PROPELLERS

The Air Registration Board have approved an increase from 1,250 hours to 1,500 hours between overhauls of the propellers fitted to the Elizabethan airliners of British European Airways.

These four-bladed hydromatic feathering propellers, 16 ft. in diameter, are manufactured by de Havilland Propellers, Limited, Hatfield. Their overhaul life, originally set at 400 hours, has been steadily increased since the first of B.E.A's fleet of aircraft went into service in March, 1952.

LIMITATIONS OF ELECTRICITY

EXPANSION IN THE NEXT TEN YEARS

An inaugural address entitled "The Next Ten Years of Electrical Engineering" was delivered at the Imperial College, London, by Professor A. Tustin on his appointment to the chair of Heavy Electrical Engineering and Head of the Electrical Engineering Department. The impact on technical progress of the young men who began their engineering courses last October would, he said, not occur for between 10 and 50 years. It was consequently appropriate to consider what engineering might be like at the time when the students now in training would be carrying it forward.

There was a general conviction that, given a long period of full employment, a sustained rise in our standard of living would be ensured by scientific and technical progress. This might be true, but developments of the order envisaged would not be guaranteed simply by the promise of nuclear power and the advent of the "automatic factory." The existence of nuclear power stations might remove an obstacle to production, but had no other relation to it. The nature of the contribution made by the electrical engineer's development of automatic control and calculating machines was also commonly misunderstood. A radical and multifarious revolution in our industrial life would therefore be necessary if our standard of living was to be doubled within the next 25 years, and the part these particular inventions might play in this change might consequently be indicated.

A CORRECTIVE OF EASY OPTIMISM

It must be remembered that only one third of our working population was employed in manufacturing, so that if productivity in manufacturing alone were doubled the standard of living would increase at the most by one third. In fact, for it to be doubled the output per worker per hour in manufacturing would probably have to be increased about three times. It would be a corrective of easy optimism to picture what was implied technically in the assumption of such an overall multiplication in productivity. It was often stated, for instance, that the principle of automatic control by feed-back would make great reductions in labour possible.

Actually, however, this principle was of very limited application, although it was a natural inference from the achievments in weapon control during the war that there were many industrial operations which were capable of complete mechanisation. It was therefore perhaps a little disappointing that there had been relatively few applications of feed-back control, except in the chemical industry. One reason for this was that economic limitations that applied in industry did not affect military activities. A more basic cause was that comparatively few of the industrial operations on which human beings were employed belonged to this class of regulation or control.

The developments that were usually cited as indications of the coming of the automatic factory were not control systems at all, but developments of familiar automatic mechanisms such as the capstan lathe and the automatic record changer on the gramophone. The techniques used in producing what was referred to as automation were an amalgam of mechanical and electrical devices, including the use of compressed air for supplementing electrical operations for pushers and clamps. Feed back control played a useful, but essentially minor, role.

AUTOMATIC COMPUTERS

These developments must be associated with another innovation—the automatic digital computer. The significance of this device on our industrial future was the subject of much speculation and some genuine investigation. It opened up the possibility of mechanising certain classes of operation that were now carried out by clerical labour. Analogue computers were also receiving increasing application; and it was suggested that by a combination of these two devices it would be possible to calculate continuously the control adjustments required on a chemical plant or the most economic allocations of loads to stations on an interconnected power system.

LIMITATIONS OF AUTOMATION

Continuing, Professor Tustin said that if the desired increase in productivity was to be achieved during the next decade or two, human operators must largely be replaced by automatic mechanisms. A little arithmetic would, however, show how limited was the field for the economical application of such mechanisms when their first cost and maintenance were taken into account. Half our output of manufactured goods was made in the 50,000 establishments employing less than 400 persons so that the exploitation of expensive automatic machinery might require the consolidation of production into more specialised or larger units. Our hopes for a much higher standard of life could not therefore be justified by this single group of innovations in the field of mechanisation. They might be justified as the use of new materials was developed and progress took place in chemistry and agriculture. The fact that our population was becoming healthier and better educated would contribute, while the development of a new outlook in management, and the evolution of a more functional structure in industry, were also important factors.

EXPANSION OF THE ELECTRICAL INDUSTRY CERTAIN

The view of the future that had been suggested implied that the electrical industry would expand in much greater ratio than production in general. Increased productivity meant a greater consumption of electricity per unit of average product; and rises in real consumer income would result in more being spent on electrical apparatus and amenities. There were some fields in which particularly great developments would take place during the next ten years. These included the electrification of railways, while an increase of our power station capacity of, say, 80,000 MW implied the production and installation of electric motors with a total output of some millions of horse-power. One contribution to the national economy that was urgently needed was a better basis for the design, selection and application of motors from the point of view of economy in first cost and power consumption, and it was hoped that an investigation which had been begun into the use of motors of incorrect size and uneconomical operation would result in considerable savings. A substantial programme of activity was also in progress on the dynamic behaviour of electrical machines and on the fundamental physical limitations that were met with in their design.

PILOTLESS POSTAL SERVICE

In the field of communication a further stimulus would be given by colour television and by improvement in the design of receiving sets. The intense activity in this field by the defence services would in time contribute to civil applications, and we might see the day when mail would be carried by pilotless aircraft. Telephone and telegraph exchanges would be radically different as electronic devices replaced switches and relays. Improved transistors, associated with mass-produced printed circuits, would be the bases of much communication equipment; and devices would be provided for the automatic routing of messages to avoid congestion.

Some possible, but less predictable, developments might take place in electro-neurology, as well as in medicine and biology, where electrical devices were already being used for counting and sorting blood cells, the automatic control of anaesthesia and in diagnostic and manipulative instruments of many kinds.

SOME LINES OF RESEARCH

As regards materials the electrical engineer would like a substantial improvement in conductivity or in the limiting magnetic induction in the metals economically available, but the physicists held out no hope of this. The physics of solids, had, however, recently given us the transistor, the solid-junction rectifier and magnetic materials with rectangular hysteresis loops or very low conductivities. This field of research was to be developed at the Imperial College to include all kinds of interaction between matter and the whole spectrum of electromagnetic radiation. Progress was also being made in supersonics, where electric waves of frequencies up to thousands of times those of audible sound might provide a substitute for X-rays or a means of improving the mechanical properties of metals. A deeper understanding of the physics of long-familiar phenomena might lead to vehicles in future being operated from electric motors fed from thermo-electric generators, which obtained heat from burning fuel; and to some arrangement of converting chemical into electrical energy without an intermediate conversion to heat.

IMPLICATIONS FOR HIGHER TECHNICAL EDUCATION

Each new design, each new invention, each new concept and each new step forward in organisation, the lecturer went on, must be the work of a person with both ability and training. The sifting process of the school and university and of the scholarship system provided a "cream" of some 3 or 5 per cent. of the total students, and there were not and never could be enough of this class. This deficiency could not be avoided by putting more men through this institution or that. Our rate of progress might consequently be limited by human ability, and the first problem was therefore how to allocate what might be called "graduate quality" men between such needs as government and administration, business, medicine, teaching and industry. In recent years, just under one-third of the university student population studied science and technology, and it seemed unlikely that any drastic increase would take place.

In considering how the training of "graduate quality" men might best be arranged it must first be recognised that they were scarce and that their training must not be inferior to the best that could be given. It must also be recognised that even within this group there was an enormous range in quality, and as this handicapped the best students some grading between institutions or courses was desirable. This might come by evolution, although there were obvious forces working in the contrary direction. Nevertheless, given an intake of students not too heterogeneous or variable in ability, most of the problems about the level and type of tuition would be settled in each institution by the practical educational sense of the maximum rate at which his students could learn.

As regards the Electrical Engineering Department at the Imperial College, magnificent work had been done by Professor Willis Jackson in building up its activities in close accord with the needs in new fields and of the future. Under Mr. Hopkin the pace had not slackened and the Department now had a teaching staff of 25 with a total of 61 post-graduate students. To meet the needs of the future it was desirable to concentrate on a limited number of fields in which post-graduate training could be high. These would include electron-physics, properties of materials, supersonics, acoustics, the control, design and economics of power systems and the fundamental limitations of electrical machines. Researches would also be made in nuclear power and, in collaboration with other Departments, on automatic control.

Book Reviews

DEVELOPMENT OF FIREARMS

A History of Firearms: From Earliest Times to 1914. By W. Y. CARMAN. *Routledge and Kegan Paul, Limited*, 68-74 *Carter-lane, London, E.C.*4. (16*s.*)

In his introduction Mr. Carman says that for the purposes of his book dates are more important than people. This may be so when dealing strictly with the development of firearms, but to see the subject in perspective it is useful to consider the influence which the various developments have had on people. In this case the main effects have been on the art of war, the development of science and in some cases on history itself. If we limit ourselves to the scope and period of the book under review, the influence of the firearms described has been very great. At about the time of the introduction of gunpowder the feudal system was at its height. The barons wielded great power, and with considerable forces of knights and infantry at their command they could be a thorn in the flesh of a king, who could not always afford the cost or the time required to reduce their castles by siege. Thus the central government was at that time comparatively weak.

The discovery of gunpowder and the development of cannon put into the hands of the king a method of breaking down the walls of castles and thus of imposing his will on the barons. In the early days development was therefore directed mainly for siege purposes. As the cost of cannon and the facilities for making them were generally beyond the means of the barons, the power of the king and of his central government was greatly increased. Once the barons were subdued the king could pay more attention to such things as the building up of naval power. Henry VII and Henry VIII were quick to see the application of cannon to war at sea, which hitherto had been fought by grappling, boarding and hand-to-hand combat. The speedy adoption of these new weapons and methods gave the English Navy a decisive advantage, and command of the sea passed gradually from Spain to England. The implications of this affected the history of the world for many centuries.

Once the castle was no longer invulnerable, increased attention was given to firearm development for mobile operations. Landmarks were the development of the bayonet, which meant that the pike and musket were combined into one weapon, and the introduction of the percussion cap which reduced the incidence of misfires from 1 in 4 to about 1 in 400. The effects of these two developments on infantry tactics were very great. The introduction of the machine gun by Maxim, so well described on page 85, had the greatest effect of all. Combined with artillery fire the machine gun made tactical movement almost impossible and led to the trench warfare methods of the first World War. It was only the development of the tank which enabled mobility to be regained.

The urgent need for improved weapons was one of the main spurs to early engineering and scientific advance. It was the recurring requirement for more, bigger and stronger cannon which led to the development of heavy industry and to the beginnings of the science of metallurgy. The science of ballistics was rapidly developed to cope with the solution of problems concerning elongated spun shell and supersonic velocities. The science of modern gunnery was founded by the Rev. W. F. Bashforth, a mathematician of repute, who in 1864 was appointed as the first Professor of Applied Mathematics at the Advanced Class at Woolwich, now the Royal Military College of Science at Shrivenham. So much was weapon development in the van of scientific and engineering progress that between 1750 and 1890, 26 officers of the Royal Artillery became Fellows of the Royal Society and one was President for four years. It is clear also that the development of weapons has had a considerable influence on contemporary history.

Mr. Carman's book is written with a pleasing sense of humour. (An amusing light on the standards of the past is the reference to the privilege accorded to a Christian enemy of having round shot used against them, square shot being reserved for infidels.) He has contrived to compress a large amount of material into a small compass. He has limited the subject matter strictly to firearms and brings his narrative to a close in 1914. It would perhaps have been better if the concluding date had been 1900 or even earlier as he gives scant attention to the very rapid advances which took place in the early years of this century.

The subject is arranged in chapters on the various types of weapon and deals in historical sequence with each in turn; ammunition is treated separately in this way. Some may find this treatment confusing particularly in the case of ammunition, the development of which is so closely bound up with the weapon which fires it. The book is fairly well illustrated, but its value to the serious student would have been increased if more drawings had been included. A number of interesting developments are described and these are not always easy to follow without an illustration; this applies particularly to some ingenious weapons which appeared years before their time.

There are a few technical inaccuracies to which attention should be drawn. On page 55 the impression is given that heavy projectiles are more affected by gravity. In fact, all projectiles are equally affected. When discussing the relative advantages of the revolver and automatic pistol on page 148, the author has omitted to mention that the "automatic" is intended to fire single shot and has the great advantage of quick reloading by inserting a new magazine. The revolver was chosen at that time as being the simpler and safer weapon; moreover, the "automatic" was not completely reliable particularly when dirty. On page 161 it is suggested that the finer the grain of gunpowder the slower it burns. In fact, the reverse is true. Fine powder was satisfactory for small weapons because fast burning was needed; larger weapons, including mortars, required slower burning powder and the larger grain achieved this by reducing the area of burning surface. A similar error occurs on page 163. The uneven burning of gun cotton was due, not to the presence of air, but to the fact that the area of burning surface was unpredictable. On page 165 the American equivalent of cordite is mentioned; it was of course a single-base propellent containing no nitroglycerine. There is a misprint in the caption of Fig. 28 on page 166: item J should be "fixed" ammunition and, in the drawing, the mouth of the cartridge case should cover the base of the shell. The book gives only brief reference to the problem of obturation and does not refer to the vital function of the cartridge case in achieving this.

Nevertheless, the book is a valuable introduction to the history of weapons. Many who read it will catch the author's enthusiasm and will wish to study further this fascinating subject. The bibliography at the end of the book will be a most useful lead for them.

LAW IN THE WORKSHOP

Industrial Law. By J. L. GAYLER. *English Universities Press, Limited*, 102 *Newgate-street, London, E.C.*1. (30*s.*)

Industrial law—by which is meant broadly the law of employer and employee, the Factories Acts, and the trade unions—is rapidly becoming the province of the specialist, not only within the law but also within industry. Specially appointed personnel officers, full-time in the largest institutions, handle relations with employees and, to a certain extent, negotiations with representatives of the unions. Safety officers, again in the larger concerns full-time, are responsible for the observance of the wide duties of the employer under the common law and the detailed provisions of the Factories Acts.

This tendency for the subject to pass into specialist hands for detailed treatment has not withdrawn it from general concern, however, and it is becoming increasingly important for all those in industrial management to have both a general knowledge of the principles of industrial law and an appreciation of the practical application of these general principles. There is a double advantage to be gained from this: in the first place come the immediate benefits from a day-to-day application of the principles in smoothing over doubts and difficulties which arise in relations with employees, and in the improvement of working conditions. Less obvious are the long-term advantages which undoubtedly accrue to those who, from a study of the practical application in everyday affairs of logical reasoning, improve their worth by the development of foresight and the anticipation of probabilities.

Whether it is unaided and in his own time that the industrialist undertakes his study of the subject, or as a student in a course of instruction organised by correspondence or classes, he will undoubtedly find much useful material in a readily digestible form in this book by the Principal of the Newcastle-upon-Tyne Municipal College of Commerce.

There are, of course, weak points in a book designed to cover a great deal of ground in a simple and fairly precise manner. The short mention in a page or two of pay during sickness, for instance, is a little out-of-date in post-war conditions, when most unskilled as well as skilled workmen earn weekly wages and are therefore entitled to full pay during sickness unless they agree to take less. The book is already out of date unfortunately, too, in the discussion of Bonsor's case; the Court of Appeal have only just been reversed in the House of Lords, and there still seem to be wide differences of opinion on the implications of the decision.

One of the principal virtues of the book is its clarity of thought and expression. Two subjects, for instance, which often give trouble even to lawyers—conspiracy, and the rights of action which arise from a breach of statutory duty—are dealt with adequately and concisely in a few pages, and the approach to the more familiar subjects of vicarious liability and the duties owed by employer and employee to each other is neat if conventional. Under this second heading there is scope for a more detailed treatment of the duty of the employer to provide a safe system of work; so there is, too, for the position of the independent contractor, and the carelessness of the workman himself which falls within the scope of contributory negligence, for all these three matters are of considerable daily practical importance and have been well illustrated in recent decisions of the courts.

The approach of the author is that of a lawyer—the deduction of working principles from the decisions of the courts, rather than the formulation of hypothetical every-day situations followed by the application of legal principles and a substantiation of the conclusions reached by decisions on point. There is no reason though to suppose that the industrialist will find any difficulty in approaching the subject along these lines. Illustrations of the application of principles in one sphere of industry will immediately suggest to the practical mind the implications within other more familiar spheres, and an appreciation of the lawyer's approach to the subject will help to avoid the drawing of false general conclusions from particular cases. It is in this that so many amateurs of the law go astray. The practice of law consists to a large extent in the application of pure logic, and there is considerable scope for this in the workshop.

BOOKS RECEIVED

Some of the books noticed here are selected for extended review in ENGINEERING.

An Introduction to Mineral Dressing. By E. J. PRYOR. *Mining Publications, Limited,* 482 *Salisbury House, London Wall, London, E.C.*2. (70*s.*)

The purpose of this book is to set out the basic principles which underlie sound milling practice and to show their relation to standard commercial operations. A milling plant is described as being a place where run-of-mine ore is received and treated, and from which end-products are dispatched. The various methods of crushing and grinding are first dealt with, then follow descriptions of methods of separation including gravity separation, chemical methods, froth-flotation and similar processes, and magnetic treatments.

Metals Reference Book. By COLIN J. SMITHELLS. In two volumes. *Butterworths Scientific Publications,* 88 *Kingsway, London, W.C.*2. (168*s.*)

The object of the *Metals Reference Book* is to provide a convenient summary of data relating to metallurgy and metal physics. The first edition of the work was published in December, 1948, and the necessity for the present second edition has given the opportunity for a thorough revision. Several new sections have been added; they cover elastic properties and damping capacity, the physical properties of molten salts, and friction. These and other changes have necessitated producing the book in two volumes. The arrangement of the subject matter, however, is the same as that adopted for the first edition. So far as possible the data are presented in the form of tables or diagrams.

Material Utilisation in the Metal Working Industries. *Institution of Production Engineers,* 10 *Chesterfield-street, London, W.*1. (5*s.*)

A sub-committee of the Research Committee of the Institution of Production Engineers, set up to investigate the extent to which British industry is making the best use of materials, has now published this, its first report. It is confined to the metal-working industries and is based on case studies collected from industry. The report is set out in three main sections concerned, respectively, with a general survey of the present position, illustrated case studies, and conclusions and recommendations.

The Inspection and Testing of Metals. Lectures delivered at the Institution's Refresher Course, 1954. *The Institution of Metallurgists,* 28 *Victoria-street, London, S.W.*1. (15*s.* 6*d.*)

The five lectures delivered during the eighth refresher course organised by the Institution of Metallurgists have now been published in brochure form. The lectures comprise "The Inspection of Metals in Service," by Mr. G. A. Cottell; "Inspection in the Steel Industry," by Mr. J. F. Hinsley; "Inspection of Non-Ferrous Metals," by Mr. S. S. Smith; "The Assessment of Methods of Destructive and Non-Destructive Testing," by Dr. H. Harris; and "Batch Testing and Sampling of Metals," by Mr. H. J. Curnow, O.B.E.

Specifications, Tolerances, and Regulations for Commercial Weighing and Measuring Devices. U.S. National Bureau of Standards Handbook, 44-2d edition, 1955. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (1 dol.)

The present edition of the handbook supersedes the previous one published in 1949 and presents a complete revision of the contents. The revision has been the responsibility of the committee on specifications and tolerances of the U.S. National Conference on Weights and Measures, which has acted in co-operation with the Office of Weights and Measures of the U.S. National Bureau of Standards.

The Writings of David Barnard Steinman relating to the Design, Construction and History of Bridges, including Contributions to the Development of the Engineering Profession, 1909-1954: A Bibliography. *Rensselaer Polytechnic Institute, Troy, N.Y., U.S.A.* (No price given.)

This bibliography is strictly confined to those published writings of Dr. David Barnard Steinman that deal with bridge engineering, engineering science generally, and with engineering as a profession. (Specifically excluded are reports of his activities and bibliographical accounts from the Press, and also his poetic writings.) Dr. Steinman, who has been acclaimed by many as the outstanding bridge designer now alive, has a most formidable list of publications to his credit, and the present bibliography contains about 200 entries on such widely diverse subjects as mathematics, form and aesthetics, specification, bridge design, technical education, ethics, professional organisation and the registration of engineers.

Brazing Manual. Prepared by the Committee on Brazing and Soldering of the American Welding Society. *Reinhold Publishing Corporation,* 430 *Park-avenue, New York* 22, *N.Y., U.S.A.* (4.75 dols.); and *Chapman and Hall, Limited,* 37 *Essex-street, London, W.C.*2. (38*s.*)

Intended for designers, metallurgists, engineers, production men, supervisors and executive staffs, the *Manual* describes the principles, equipment and procedures involved in brazing processes. Preliminary cleaning and surface preparation and final cleaning and inspection are among other subjects dealt with. The book covers the techniques of brazing aluminium, magnesium, copper, steels, iron, nickel and other metals.

Standard X-Ray Diffraction Powder Patterns, Vol. V: Data for 45 Inorganic Substances. By HOWARD E. SWANSON, NANCY T. GILFRICH and GEORGE M. UGRINIC. National Bureau of Standards Circular 539. *The Superintendent of Documents, U.S. Government Printing Office, Washington* 25, *D.C., U.S.A.* (45 cents.)

Forty-five standard X-ray diffraction powder patterns are presented in revision of 74 corresponding patterns in the file of the American Society for Testing Materials. This is a system for the identification of unknown crystalline materials based on the three strongest reflections of each material or structurally distinct phase. Patterns for five compounds not represented in the file are also included. A comparison is made of all powder diffraction data available for each of the substances reported.

Whitaker's Almanack, 1956. *J. Whitaker and Sons, Limited,* 13 *Bedford-square, London, W.C.*1. (17*s.* 6*d.*)

In this, the 88th edition, a concise list of the principal ships of Her Majesty's Fleet, with notes on their tonnage, armament and speed, has been restored after an absence of many years. The weights and measures section has been entirely revised, and fresh tables substituted for material of less general current interest.

Die Kreiselpumpen für Flüssigkeiten und Gase: Wasserpumpen, Ventilatoren, Turbogebläse, Turbokompressoren. By CARL PFLEIDERER. Fourth edition. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (58.50 D.M.)

This is the fourth edition of "Centrifugal Pumps for Liquids and Gases." The condensed treatment of the subject enables those studying suction and delivery to gain the necessary insight into the principles involved. It also meets the needs of the practical engineer by including related subjects so as to cover a wide range of technical information. The type of machinery dealt with is applicable to compressible as well as incompressible fluids, and covers water pumps, fans, turbo-blowers and turbo-compressors. The first 100 pages are devoted to the basic features associated with the theories concerned. Constructional information is then given, supported by a large number of examples of calculations together with 386 diagrams and illustrations. There is an appendix on self-priming centrifugal pumps.

Das Cross-Verfahren: Die Berechnung biegefester Tragwerke nach der Methode des Momentausgleichs. By JOHANNES JOHANNSON. Second edition by GÜNTER RACZAT. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.* 35. (17.40 D.M.)

This book, in its second edition, gives a full description of the Cross method for calculating the bending strength of supporting structures according to the moment compensation method. To understand all the derivations, it is said that the Mohr theorem should be known although this is not absolutely necessary if the Cross method is only to be used as a routine procedure. Explanations of the principles involved are supplemented by practical examples illustrated with diagrams and accompanied by relative calculations.

Regelungstechnik: Kurze Einführung am Beispiel der Drehzahlregelung von Wasserturbinen. By GEORG HUTAREW. *Springer-Verlag, Reichpietschufer* 20, *Berlin, W.*35. (18 D.M.)

"The Technique of Control" is a short introduction to the subject, based on the example of controlling the speed of rotation of water turbines. It is intended for students and practical engineers who have not had occasion to go closely into problems of control. Methods of calculation are given, the most important questions arising in relation to control are pointed out and the usual calculation is explained. By handling the subject on the basis of a concrete example it has been possible to emphasise the physical side of the problems and thereby facilitate understanding, but it does not exclude the possibility of generalising the knowledge and applying it to other problems of control. The text is supported by diagrams and formulae.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Research in Rubber. DUNLOP RESEARCH CENTRE, Fort Dunlop, Birmingham. Fundamental and applied research in rubber and certain materials replacing rubber; application to industry, agriculture, transport, aviation, medicine, sport, and the home; fundamental research in physics and chemistry, compounding, textiles, latex, synthetic rubbers and plastics. Excellently illustrated and produced book.

Heat Insulation. WILLIAM KENYON AND SONS LTD., Dukinfield, Cheshire. The theory of heat transfer and insulation, economics of insulation, thermal insulation materials, and the practical application of thermal insulation with several examples. Illustrated book with many good illustrations and diagrams, useful as a reference work for architects, builders and consumers of power.

Research Institute. SONDES PLACE RESEARCH INSTITUTE, Dorking, Surrey. Organisation for sponsored research and development in chemistry, chemical engineering, and mechanical engineering; laboratory research, pilot plant development, plant design and prototyping, analysis and testing. Illustrated booklet.

Dust Collectors. DAVIDSON AND CO. LTD., Sirocco Engineering Works, Belfast. Sirocco R-type dust collector consisting of standard cells fitted with vanes; cells can be built up into required size for volume of gases; separation of dust on centrifugal principle, vanes giving swirling motion to dust-laden gases. Illustrated leaflet.

Flexible Couplings. HOWARD CLAYTON-WRIGHT, LTD., Wellesbourne, Warwickshire. Harrisflex (Torflex) couplings. Small range covering shaft diameters up to $1\frac{1}{2}$ in. and torques up to 825 lb.-in.; rubber bearing accommodate misalignment and will allow connection of driven and driving shafts of different diameters. Illustrated leaflets.

Acid-Resistant Immersion Heater. THE THERMAL SYNDICATE LTD., Wallsend, Northumberland. Vitreosil demountable electric immersion heaters for heating acidic liquids; d.c., single and three phase a.c. in various ratings and voltages. Illustrated leaflet.

Grease Gun. SIR THOMAS EDELSTON AND PARTNERS LTD., 28–30 Sussex-place, London, W.C.2. High pressure grease gun designed for one-handed use; provided with valve for bleeding air pockets from grease; fitted with standard hydraulic connectors, and other types available. Leaflet.

Mobile Cranes. RANSOMES & RAPIER, LTD., Waterside Works, Ipswich, Suffolk. Mobile cranes of 3 to 10 tons capacity, particularly the 8 and 10 super models with extended jib for cargo handling in docks. Brief specifications. Illustrated booklets.

Modular Construction. MODULAR SOCIETY LTD., 22 Buckingham-street, London, W.C.2. The fifth issue of sheets for the modular catalogue; Nos. 20 and 21 relate to curtain walling, and No. 22 to steel framework. Dimensioned drawings of components. Loose-leaf pages.

Wagon Tipplers. HENRY LEES AND CO. LTD., Motherwell, Scotland. Dimensioned general arrangements of five types of wagon tippler: portal, rope/ram, gear/ram (end door), rope/ring, and gear/ring types. Mechanical discharge of wagons. Illustrated broadsheet.

Corrosion Protection. ALUMINIUM UNION LTD., The Adelphi, London, W.C.2. Use of magnesium anodes for cathodic protection against corrosion of underground or underwater structures. Illustrated leaflet.

Spectrophotometer Cells. THE THERMAL SYNDICATE LTD., Wallsend, Northumberland. Vitreosil (pure fused quartz) cylindrical and rectangular spectrophotometer cells for ultra-violet absorption experiments. Illustrated leaflet.

Concrete Mixer. RANSOMES AND RAPIER, LTD., Waterside Works, Ipswich, Suffolk. The 7T concrete mixer with tilting drum, 10 cub. ft. charging hopper and syphon water tank holding 8 gallons. Illustrated leaflet.

Hydraulic Shovel. CHASESIDE ENGINEERING CO. LTD., Station Works, Hertford. The "Loadmaster" hydraulic shovel fitted with optional power-assisted steering. Illustrated broadsheet.

Dust Control Equipment. DALLOW LAMBERT & CO., LTD., Thurmaston, Leicester. Collectors, hooding, booths, filters, etc. Pictorial leaflet.

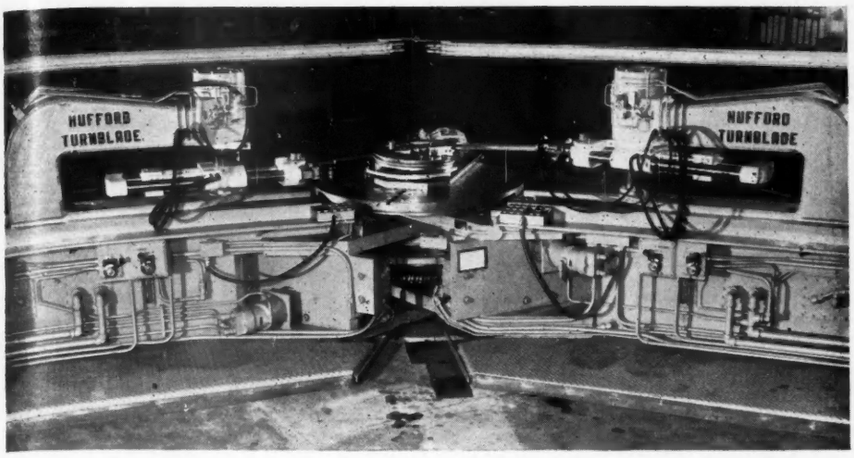

Fig. 1 The Hufford Turnblade Carousel, a Douglas invention, is seen here forming strip material through a 360 deg. bend. One end of the strip is held by one of the rotating-arm cylinders and the other by a stationary cylinder. The other rotating-arm cylinder, not working, is tooled for roll-forming.

SOME ASPECTS OF THE AMERICAN AIRCRAFT INDUSTRY

(3) MATERIALS, PROCESSES AND MACHINES

In the first and second of these articles on the American aircraft industry, we described the varied activities and some research and development trends observed in the factories we visited. This third article is concerned with developments in materials, manufacturing processes, and machines in the aircraft firms. The fourth and final article will be concerned with some aspects of production in the engine and propeller firms.

One of the features of American aircraft engineering which most impressed us was the great importance attached to materials and manufacturing research and development groups whose function is, in the words of one of the Boeing representatives, " to work out the dreams of engineering."

METALS

Titanium and its alloys have, of course, been the subject of much development by the American firms, and the Douglas company are making considerable use of it in the nacelles of their DC 7 airliner; General Electric are also utilising it widely in the prototype J79 turbojet, whereas Pratt & Whitney Aircraft are more conservative. It seems that no particular difficulty has been encountered in hot or cold forming of commercially pure titanium sheet, and that the problems of welding and cutting it are now largely overcome. Lockheed have found that commercially pure titanium can be formed readily by drop hammer at temperatures from 700 deg. to 1,100 deg. F., and they have developed a technique for drawing deep beaded parts for cargo doors.

Lockheed have also carried out considerable research on a precipitation hardening stainless steel, Armco 17-7 PH. This steel, normally supplied in the annealed condition with a maximum tensile and yield strength of 150,000 lb. per square inch and 50,000 lb. per square inch respectively, and a minimum elongation of 20 per cent., can be formed into complex shapes and subsequently heat-treated to raise the strength—a procedure impossible with the more commonly used types of stainless steel. After forming, the part is heated to 1,400 deg. F. for 1½ hours, air cooled below 60 deg. F., and held at that temperature for ½ hour; it is then aged at 1,050 deg. F. for 1½ hours, to obtain the following minimum properties—tensile strength, 180,000 lb. per square inch; yield strength, 150,000 lb. per square inch at 0·2 per cent. offset; elongation, 6 per cent. in 2 in. The processing is critical and if not carefully carried out can result in under-strength or brittle parts.

The Lockheed engineers have also established that 4–6 per cent. and 8–10 per cent. chromium steels can be flash-welded after heat treatment, and still retain a reasonable strength, in the region of 180,000 lb. per square inch ultimate. Lockheed are not currently using these steels in production, but it appears that these straight chromium steels could profitably replace the chromium-molybdenum steels which require a drastic quench after flash-welding followed by a straightening operation.

We learnt of several new promising light alloys which are under evaluation by Avro Aircraft Limited. A number of forgings in their prototype supersonic aircraft will be in Alcoa X 7079S, an aluminium-zinc-magnesium alloy which has four times the ductility, in the short transverse direction, of currently-used 75 S alloy, which it resembles.

Among magnesium alloys under development are two sheet materials, Dow ZE41, a high-strength magnesium-zinc/rare-earth alloy, and HK31, a 3 per cent. thorium, 1 per cent. zirconium-magnesium alloy; and a magnesium-thorium casting alloy, ZH62. All these materials have satisfactory properties, including reasonably good fatigue resistance, at temperatures up to 250 deg. F., and are capable of practically 100 per cent. recovery of room-temperature properties after exposure to temperatures of 400 deg. F.

The high-heat-treat steels that have been developed in the United States, with ultimate strength of 260,000-280,000 lb. per square inch have, generally, low impact strengths and ductility. For some components these properties are acceptable, but for general use in aircraft design greater toughness and ductility is desirable. Avro Aircraft, therefore, have been encouraging steel manufacturers to develop the properties of the standard B.S. S28 steel. By insisting on a cleanliness equal to that of ball-race steel, and by limiting the section dimensions to 1½ in., the ultimate tensile strength has been raised into the 240,000—260,000 lb. per square inch range. Under controlled laboratory conditions the fatigue resistance is reasonably good; the Izod value is 20 ft. lb. and the reduction of area is about 40 per cent. Avro envisage using this steel for such items as landing-gear attachment brackets, etc., where high strength is required because the available storage space is a minimum.

STRETCH-FORMING 360 DEG. AND REVERSE BENDS

The technique of stretching metal sheet beyond the yield point and then forming it to the desired shape, to ensure accuracy of profile and dimensions, is now thoroughly established practice on both sides of the Atlantic. These stretch-forming techniques were largely pioneered by the American aircraft firms, notably by the North American Aviation Company, before they were taken up by machine-tool manufacturers such as Sheridan and Hufford.

At the El Segundo division of the Douglas company we saw two stretch-forming developments that have not yet been used in the United Kingdom. The latest version of the well-known Hufford stretch-wrap forming machine, in use during the past three years at Douglas for forming titanium sheet as well as light alloy, and illustrated in Fig. 2, is now fitted with contoured jaws in place of the straight jaws which are in current use here. These jaws can be adjusted for convexity or concavity, and are rotatable about both horizontal axes; Douglas say that this greatly facilitates the satisfactory forming of complex contours.

COMPLEX CONTOURS

The other development, invented by Mr. Charles Turnblade of the Douglas company and constructed by the Hufford Machine Works, is a most versatile machine capable of forming highly complex contours, including 360 deg. bends, reverse bends, and coiling material not exceeding 6 in. in width. The two rotating arms carrying the double-action hydraulic tension cylinders rotate independently in either direction. In addition to stretch-forming functions, either arm can be tooled for wipe forming or roll forming, and the cylinders can be reversed to provide " push " instead of " pull." A third stationary cylinder, also exerting push or pull, is mounted on an extension to the die table, enabling a wider range of operations to be carried out, such as simultaneous stretch and roll forming, punching or joggling. The machine in use at Douglas, shown in Fig. 1, can handle sheet up to 216 in. long by 22 in. wide and develops a maximum torque of 1,350,000 lb. in. In this illustration, the workpiece is being formed through a 360 deg. bend by one of the rotating-arm cylinders and the stationary cylinder; the

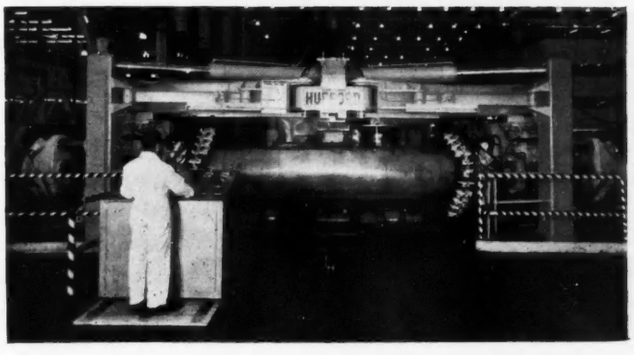

Fig. 2 This Hufford stretch-forming machine, here shown in process of forming titanium sheet material at the Douglas El Segundo division, is fitted with adjustable-contour jaws.

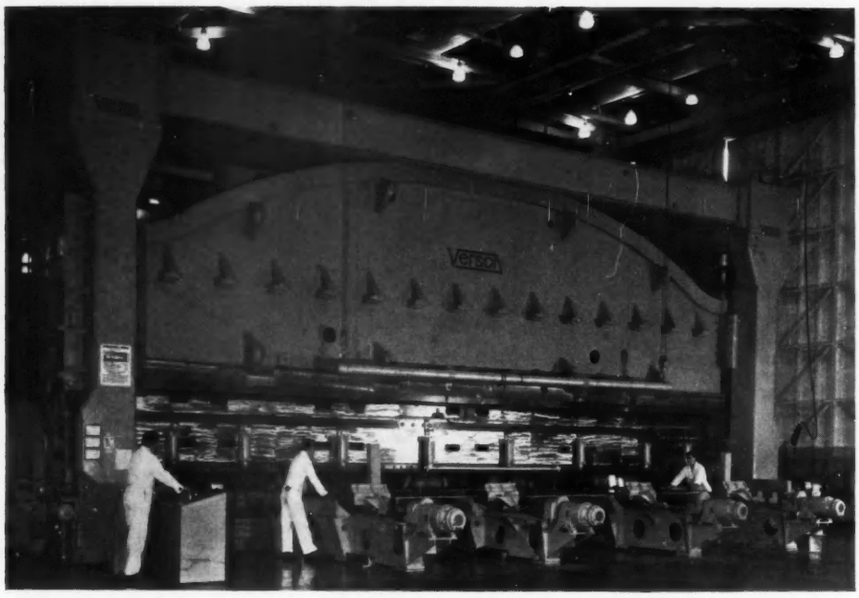

Fig. 3 Skin panels up to 40 ft. long and 1 in. thick can be contoured in this Verson brake press at the Douglas El Segundo division.

other rotating arm, not in operation here, is seen tooled for roll forming.

RUBBER PRESS TECHNIQUES

For forming large skin panels up to 40 ft. in length and 1 in. in thickness, the Douglas company have for the past year been using an 1,800 ton 42 ft. wide Verson brake press (Fig. 3). This press, which has a 24 in. stroke, is capable of bending the sheet through 90 deg. For contouring a wide sheet, the machine is automatically sequenced by photo-electric cells and notched-tape mechanisms, the sheet being fed through the press in increments of 1 in. To prevent distortion due to the weight of the formed panel as it emerges, supporting chains and rollers are disposed in a curve.

One of the most recent and elegant developments of the rubber press technique for smaller parts, now operating at pressures up to 5,000 lb. per square inch and able to cope with more complex shapes, was also seen at the El Segundo division of the Douglas company—the Wheelon automatic-cycle press, devised by a Douglas engineer and constructed for the company by the Verson All-Steel Press Company, Chicago, which employs, in effect, high-pressure oil in a rubber bag. It comprises a horizontal cylindrical pressure chamber within which is suspended an enclosed rubber cell. The latter is retracted upwards while the blank parts are conveyed into the chamber through an end door on a roller-mounted loading tray. There are two such trays operating alternately from opposite ends of the chamber, so that while one load of parts is undergoing pressure, another load can be assembled on their form blocks on the tray ready for entering the chamber as soon as the first load is withdrawn. After the tray carrying the blank parts is locked and sealed in position directly under the rubber cell, hydraulic fluid is pumped under high pressure into the rubber cell, which expands down on to and over the blanks on their form blocks. It will be realised that during the pressure cycle there are no moving parts within the pressure chamber other than the expanding cell; thus ram guideways and heavy tie-rods are eliminated, and the engineering problems of working under high pressure are simplified. In Canada, Avro Aircraft Limited are also adopting a 5,000 lb. per square inch hydraulic rubber press, which is being developed by the German firm of Siempelkamp.

Still higher forming pressures, of the order of 9,000-10,000 lb. per square inch, are a feature of the impact rubber-forming technique that has been under development at Boeing for the last two years. For this operation they use a modified Cecostamp air-operated drop hammer with a hard-rubber disc contained in the hammer head. A second hard-rubber disc is placed over the workpiece, which is formed over a bottom die. The advantages of the process are that much hand finishing is eliminated and that hot-forming is possible at temperatures up to 1,000 deg. F. since the operation is carried out so rapidly that the rubber does not burn.

HOT FORMING

The hot forming of aluminium alloy sheet is gaining ground for certain applications. The manufacturing research unit of the Fort Worth division of Convair have carried out some comprehensive research on hot forming by press brake, drawing and forming, stretch-forming and drop hammer forming on four aluminium alloys; they concluded that the hot stretch-forming of sheet material was not satisfactory, but that the application of heat when stretch forming extrusions, during press-brake forming, or deep drawing operations made for improved results in three out of the four alloys tested, and in the case of 7075-T alloy eliminated the need for heat treatment and ageing.

In an attempt to evaluate the best heating methods for hot forming, Boeing have conducted studies on resistance heating, induction heating, fluid or steam heating, and internal-combustion heating. It is perhaps a little surprising that as a result of these investigations the electrical methods are the least favoured; for temperatures up to 350 deg. F., steam heating was found to give the best results, whereas for higher temperatures internal-combustion heating proved preferable.

Avro Aircraft also are among the firms that have been investigating hot-forming techniques. For hot forming magnesium alloy skins, they find that epoxy-coated Kirksite-cored dies with externally applied strip heaters give the most satisfactory results; a glass-cloth drape serves as a heat separator to protect the epoxy resin from overheating.

PLASTICS DIES AND FIXTURES

Plastics tooling has been the subject of considerable research by several firms and is now extensively in use at Boeing, Convair and Lockheed, as press dies and forming blocks, clamping fixtures, gauges, etc. Both phenolic and epoxy resins are in use, but the latter, which can be cold formed, are dominating the field. The use of plastics tools to replace metal or reinforced-concrete dies has been found to effect considerable savings in tool manufacturing time and costs. They are lighter to handle; generally speaking they have a longer surface life; the tools can be more easily modified and repaired than metal tools; and in forming operations a better surface finish and dimensional accuracy, with a consequent saving in finishing operations, is obtained from plastics tools.

The lighter weight of the plastics dies has made possible the forming of much larger single-piece components than would have been possible with metal dies. Illustrated in Fig. 4 is a Lockheed Constellation fuselage skin panel 15 ft. long that has been formed on a phenolic-faced die in the 200-ton Hufford stretch-wrap press. This die weighs 3,500 lb.; a similar die in Kirksite metal would weigh 17½ tons and would have made handling prohibitive.

For the cores of their plastics-surfaced stretch-press dies, Lockheed are using re-cast scrap aluminium of which they have a plentiful supply from their skin and spar milling operations. The use of scrap aluminium in place of Kirksite cores cuts tool costs very considerably, and has the advantage of being appreciably lighter. In the first six months of this year, 56 aluminium-cored tools were cast, weighing 40,190 lb. The same tools with a Kirksite base would have weighed 224,130 lb. and would have cost over six times as much.

An impressive example of time savings that can be effected by the use of plastics fixtures was quoted by Lockheed. A certain master fixture for Super Constellation assembly provides for locating 90 holes with a tolerance of ± 0·0004 in. When this fixture was made in metal, some 180 hours machining was required. It has been replaced by an epoxy resin fixture, in which the holes are cast oversize. Steel bushes are then located accurately in each oversize hole, and are fixed in position by pouring in the cold-setting resin—the whole operation taking only 18 hours.

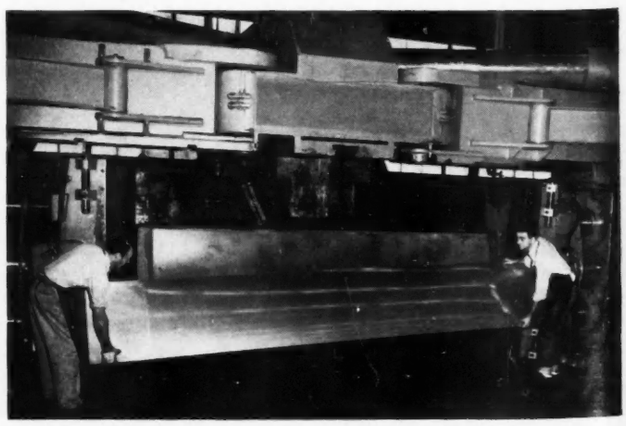

Fig. 4 At Lockheed, phenolic-resin-faced dies are used for stretch-forming 15 ft. fuselage skins. This die weighs 3,500 lb.; a metal die of similar dimensions would weight 17½ tons and could not be handled.

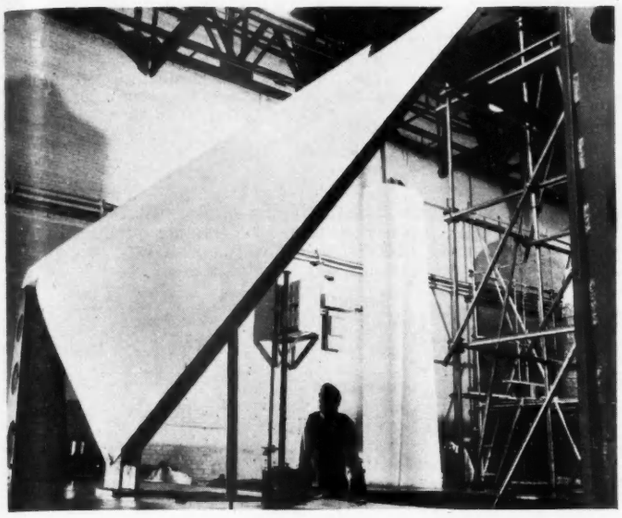

Fig. 5 Master models, built up from metal contour templates filled with a foamed phenolic resin and finished with a plaster coating, are used at Avro Aircraft for checking the aircraft lines; for marking out skin joints, rivet pitches, etc.; for making envelope forming tools or moulds for stretch-wrap dies.

DRAWINGS AND MASTER MODELS

The most interesting aspect of production at Avro Aircraft Limited is the way in which they have integrated their drafting and tooling processes, employing glass-cloth full-scale drawings and master models. Although the use of glass cloth for drawings did not originate at Avro, they have developed its application considerably. Its advantages lie in its transparency, strength and dimensional stability, and the fact that it is more easily stored than metal loft plates.

In tooling up for a new aircraft, the first step is the setting out of the lines of the aircraft on glass cloth. This then forms the basis for the aircraft master model: from the original glass-cloth master, a series of metal contour templates are printed and cut, and are mounted on a framework. The spaces are then filled with foamed phenolic resin to form the master model, and finally coated with plaster (Fig. 5). The model serves, firstly, for checking the fairing of the lines, and for marking out the skin joints. Secondly, it is used for tool manufacture; female patterns are cast from the master and re-used in turn as moulds for casting stretch-form tools. It is also used for moulding directly cold-curing epoxy-resin envelope tools for skin contouring. A further series of master templates is made and stored for future use in assembly jigs, as routing and drilling templates, inspection templates, etc.

The master-lines glass cloth, after it has been checked with the model, returns to the design office and is converted to an assembly drawing by lofting in various detail parts. From this drawing all the details and assemblies are prepared, full scale, and the requisite drawings or prints are issued to the planning and production sections for ordering tools, adding manufacturing instructions, etc.

This is a very condensed summary of the Avro drafting and tooling system, the introduction of which has proved extremely valuable in detecting and eliminating errors in drafting and interpretation and has thereby notably speeded up production.

SAWING AND ROUTING

In sheet-cutting techniques, the use of toothless friction saws has been gaining ground in the American firms; it is said to give better results on stainless steel and titanium sheeting than conventional toothed blades. The Boeing company have developed a hand-held air-driven skin saw with a carbide-tipped blade for edge-trimming wing skins up to 1 in. thick.

High-speed routing machines, operating at speeds over 20,000 r.p.m., are in use at Douglas and Boeing, but in this field it does appear that the British manufacturer is in advance of the American. We saw nothing comparable with the automatic copy-routing machines of the type that have been developed by Wadkin Limited in co-operation with the Supermarine division of Vickers-Armstrongs Limited (ENGINEERING, January 28, 1955, vol. 179, page 111). Such machines, it may be recalled, are one approach—and a promising one—to the problem of producing integrally-stiffened skins from thick sheet metal, the American solutions to this problem being out of reach, financially, to British manufacturers.

CHEMICAL MILLING

In the United States, machining, rolling, extrusion and "chemical milling" techniques are all being developed for the production of integrally stiffened components.

The development of skin-milling techniques is a field in which North American Aviation Incorporated have played a leading part. Among their latest processes is chemical milling, developed by the materials research and process group at their Downey missile plant, and now manufactured under licence by Turco Products Incorporated, Los Angeles.

Chemical milling has been applied successfully to aluminium, steel and titanium, and the equipment is said to cost less than 10 per cent. of a conventional skin mill. Briefly, the component is etched; it is masked and immersed in a suitable solution—alkaline, acid or electrolytic. The unmasked parts are etched away at a controlled rate under electronic control.

The advantages claimed for the process, as applied to aluminium alloys, are that chemical milling can be carried out after forming operations, and is not restricted as to shape, direction of cut or limiting radius of cutters. Complex cuts and sharp corners can be produced in a single operation. Metal can be removed simultaneously from both sides of a sheet, thus eliminating warping. Sheet thickness can be held to tolerances of $\pm$ 0·002 in., and lighter constructions can be used because of the elimination of manufacturing limitations. Fig. 8 shows a comparison of chemically milled and machine milled surfaces. As well as its use for complex pocketed and grooved shapes and integral stiffeners, chemical milling is suitable for tapering sheets and extrusions, and for reducing the dimensions of forgings. No further sanding or polishing is required, and the mechanical and physical properties are not impaired.

Various methods of masking have been developed: chemical resistant templates, held by clamps, bolts and nuts, or vacuum are suitable for parts without cross ribs and stiffeners. Chemically-resistant adhesive tapes are useful where it is necessary to etch to different depths in one panel, since the tape can be stripped off progressively after etching has started on the deepest section. Spray or brush masking with chemical-resistant organic coatings has been used in complex contoured panels, and a silk screen process is applicable to flat or slightly contoured panels; in this process a stencil is reproduced on a fine-mesh silk screen and a semi-liquid pigment is pressed through the screen to form the required design on the metal surface. Photosensitive organic coatings are used in conjunction with a glass-cloth negative to provide masking for matching parts of complex contours such as the sandwich construction illustrated in Fig. 6. Another method is by conventional electroplating masking techniques, copper plating, stripping the masking, and then chemically milling. The copper plate acts as the masking material for the chemical milling operation.

SKIN MILLING

Spar and skin milling techniques, pioneered by North American Aviation, Incorporated,

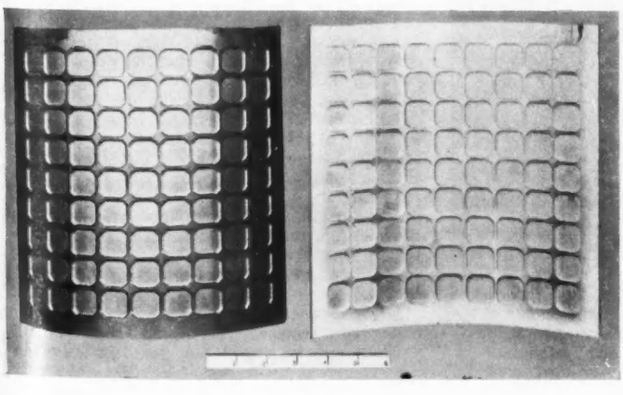

Fig. 6 Two mating skin panels of a sandwich construction formed by chemical milling at North American's Downey plant.

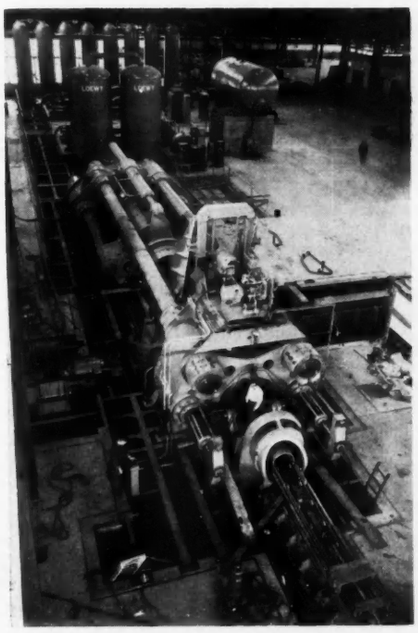

Fig. 7 This 12,000 ton extrusion press at the Curtiss-Wright Corporation's Metal Processing Division plant at Buffalo is believed to be the largest in the world.

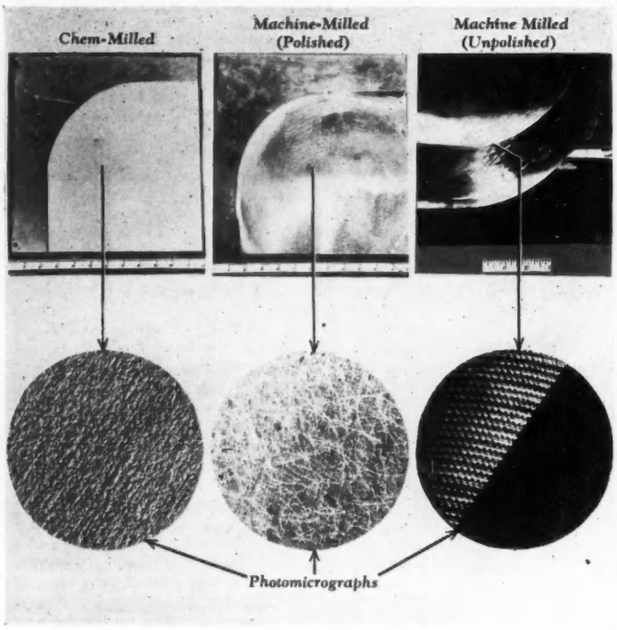

Fig. 8 Comparison of machine milled and "chemically milled" surfaces. Chemical milling is an etching process, electronically controlled, which can be applied to the production of a wide variety of forms.

some 10 years ago, are of course now well established. The Lockheed company, for example, have for some years been producing Constellation wings by such methods.

Illustrated in Fig. 9 is their Giddings and Lewis skin-milling machine in operation at the Burbank works, taking the first cut on one of the spar web panels for the 150 ft. wing of the long-span 1649A Super Constellation which is expected to fly towards the end of next year. This mill is capable of cutting, tapering and profiling slabs up to 10 ft. wide by 32 ft. long.

With an eye for showmanship, Lockheed have installed all their major machines, of which the Giddings and Lewis mill is a prime example, in a lofty building known as the "Hall of Giants." The other "giants" include an 8,000 ton Birdsboro triple-action hydraulic drawing press, 36 ft. high with foundations 12 ft. below the ground, with a bed 31 ft. long and 10 ft. wide; a Cincinnati Hydrotel copy miller; a Keller duplicating machine used primarily for die manufacture; a 120 ton Cecostamp pneumatic drop hammer; and the inevitable Hufford stretch-wrap forming press. There is also a 500 cub. ft. cold store for holding aluminium alloys at a temperature of −20 deg. F., and the necessary heat-treatment furnaces and degreasing baths; all components pass through the latter before going on to the assembly lines.

COMPUTER-CONTROLLED MILLING MACHINE

One of the most advanced machine tools brought to our notice in America is at present under construction under an Air Force contract (1,128,000 dols.) by Convair—a 200 ton electronically-controlled 18 axis milling machine which is expected to effect considerable improvements in quality and control and in time saving. The electronic control system, developed by the Massachusetts Institute of Technology, will read numerical commands from engineering data fed into a computer. These commands will guide the machine's four cutting heads, its bed and turntable.

A new system of coding engineering dimensions and formulae from drawings is being developed in terms of machine set-up, feeds and speeds for feeding into the computer, which will transcribe the information on to punched tape. This tape is fed into an electronic director from which the commands will be transferred to magnetic tape. Although the director may be used to operate the machine directly, a more versatile arrangement is to transfer the magnetic tape to an electronic console that operates the machine dimensionally. In this way the computer-director mechanism may be used to solve other problems and control other processes and duplicated magnetic tapes can operate a battery of machines.

The milling machine will have a 20 ft. bed with 10 ft. clearance, a rotary turntable, two vertical cutting heads, and two horizontal cutting heads. The cutting angles of the tools may be varied. Both vertical heads, or both horizontal heads, may be operated simultaneously, and the speed of the table can be raised. After a cutting head has obeyed the instructions of the magnetic tape and has completed its metal-shaping tasks, the head will retract automatically, and the tape will command another head to take over. The bed will be engaged and stopped automatically at the tape's command, and the turntable rotated, until the work programme is completed.

"CHIPLESS" PRODUCTION

Skin-milling processes are not, however, universally favoured. The Boeing Company do not consider that machining techniques which produce vast quantities of scrap material—introducing its own handling problems—constitute an elegant solution to the stiff-skin problem. Their present production is still largely centred on built-up skin-and-stringer combinations, using riveting and spot welding techniques, together with some metal-bonded and honeycomb sandwich construction in control surfaces, but for the future their manufacturing research group is concentrating on "chipless production": they are investigating the possibilities of precision castings and forgings—some precision forgings are already in use in the B.52—and extrusion techniques. The extrusions, produced for the Boeing company by the metal industries on large Government-owned extrusion presses, are cut and flattened by stretch-levelling or roll-levelling techniques, still under development.

Fig. 9 At Lockheed's works, a Giddings and Lewis spar mill takes the first cut on one of the spar web panels for the 150 ft. wing of the long-span 1649A Super Constellation.

One of these Government-financed presses, stated to be the largest horizontal steel extrusion press in the world, is illustrated in Fig. 7, installed in the spring at the Buffalo plant of the Curtiss-Wright Corporation's metal processing division, where forgings, steel castings, and precision-machined parts are produced. This 12,000 ton press will be used for forming steel, titanium and non-ferrous extrusions.

BONDED METAL CONSTRUCTION

Metal-bonding and honeycomb sandwich construction is under investigation by most of the American aircraft companies, including titanium and stainless-steel honeycombs, and metal adhesives are available capable of withstanding temperatures up to 500 deg. F. Generally speaking, however, these forms of construction are not widely in use. The large commercial aircraft constructors Lockheed and Douglas, for instance, are deliberately conservative in their methods and do not favour metal "gluing" for primary structure at present.

As noted already, Boeing are using metal bonded constructions in control surfaces, and they have developed a field repair unit for the rectification of damaged components. This comprises a set of flat and contoured aluminium heating blocks, used in conjunction with adjustable pressure jigs and fixtures; a flexible electrically-heated rubber blanket used for heating a variety of contours; thermocouples; and a temperature controller for automatically regulating the curing cycle.

The cutting of metal honeycomb presents difficulties on account of the burring of the honeycomb edges which interferes with satisfactory skin bonding. Boeing are now investigating electrical erosion techniques, using a high-frequency current and holding the work in a female die enclosed in a container, through which liquid is pumped to remove swarf.

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A LESSON IN LUBRICATION

Film on Porous Metal Bearings

Advertising is a technique which sometimes best succeeds when it sets out to be something else; it is also the discreet art of knowing your customer. An engineer, for example, is more likely to be influenced by a reasoned exposition than by six-foot letters of fire, and advertisements which offer him genuine information have the greatest chance of convincing him. This approach has been carried to its logical conclusion in a film made for Bound Brook Bearings, Limited, Trent Valley-road, Lichfield, Staffordshire, entitled "Porous Metal Bearings," which is largely educational in its purpose and limits the "commercial" to a minimum.

The film, which makes wide use of animated diagrams, begins with an introduction to classical theories of friction and lubrication, dealing in particular with boundary and full fluid film lubrication, and continuing with a consideration of such factors as speed, load and oil viscosity; these quantities are shown combined with coefficient of friction in a comprehensive graph, which provides a useful basis for bearing design. The second part of the film covers the design and manufacture of porous metal bearings, which by virtue of their retention of oil are effectively self-lubricating; this quality is illustrated by an electric fan which during ten years' running has required no lubrication. After showing the powder-metallurgy process by which porous bearings are made and describing their microscopic structure, the film explains by diagrams their operation and the manner in which permeability automatically stabilises running conditions.

Made for industrial presentation and for engineering students, this 16 mm. sound film is available on loan and runs for 31 minutes.

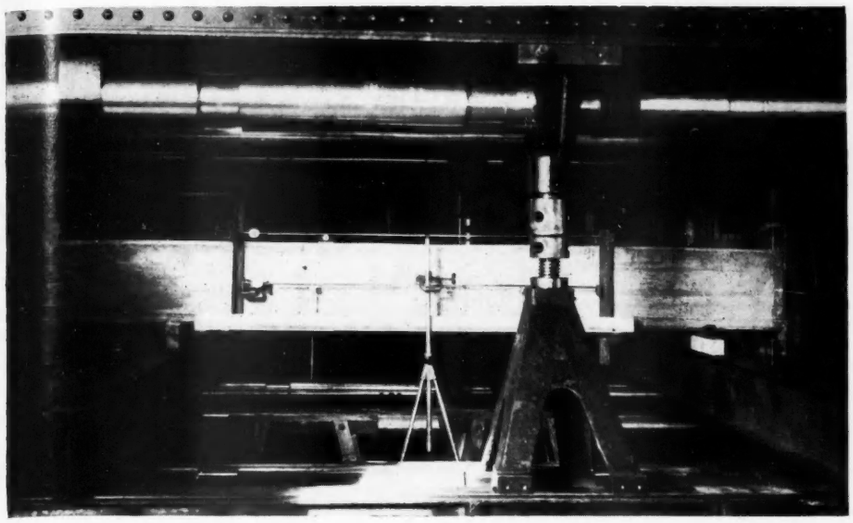

Fig. 1 A rolled steel joist, encased in concrete and 12 ft. long, under test in Dorman Long's 1,250 ton testing machine at Middlesbrough. The strain measurements were made over a gauge length of 72 in.

RATIONAL DESIGN OF CONCRETE-ENCASED STANCHIONS

FULL-SCALE TESTS SUGGEST SAVINGS IN STEEL

By Oscar Faber, C.B.E., D.SC., M.I.C.E.

It has long been appreciated that the strength of steel stanchions can be increased if they are encased in concrete. At the present, for this country, the account that may be taken of the encasing concrete is regulated by B.S. 449 (1948)*; this standard is already under review and the draft revision, B.S.* 449 (1955) *has been circulated for comment by interested parties before being finally approved, and this draft, in respect of the clauses concerned with encased stanchions, was the subject of an article by Dr. F. G. Thomas in* ENGINEERING *of December 2.*

The magnitude of the increased strength resulting from heavy encasement has been investigated in a series of full-scale tests by Dr. Oscar Faber, and on the basis of this investigation Dr. Faber has deduced a straightforward design method, suitable for drawing offices and for inclusion in the appropriate Code, that takes into account the strength of the composite member. His results were communicated in a paper presented to a joint meeting of the Institution of Structural Engineers and the British Constructional Steelwork Association in London on November 29. The paper, which includes much incidental data obtained in the tests, is to be published in full in the* Structural Engineer *for February*, 1956. *Meanwhile extracts from Dr. Faber's paper are given herewith.*

THE DRAFT CLAUSE

In the draft of the 1955 edition of B.S. 449 it was evidently felt that some greater allowance than was permitted in the 1948 edition could be made and the revised provisions for the additional strength to be obtained from the concrete surrounding steel stanchions are as follows:

Cased Struts.—Struts of single British Standard I beams to B.S. 4A, or British Standard channels back-to-back, of symmetrical I form, may be designed as cased struts when the following conditions are fulfilled:

(i) The steel strut is unpainted and solidly encased in ordinary dense concrete with an aggregate not exceeding $\frac{1}{2}$ in. and of a works strength not less than 3,500 lb. per square inch at 28 days.

(ii) The minimum width of solid casing is equal to $b + 4$ in., where b is the width of the steel flange in inches.

(iii) The surface and edges of the steel strut have a concrete cover of not less than 2 in.

(iv) The casing is effectively reinforced with wire. The wire shall be at least $\frac{1}{16}$ in. in diameter and the reinforcement shall be in the form of stirrups or binding at not more than 6 in. pitch so arranged as to pass through the centre of the covering of the edges and outer faces of the flanges and supported by longitudinal spacing bars not less than four in number.

The radius of gyration r of the strut section about the axis in the plane of its web may be taken as $0{\cdot}2\ (b + 4)$ in. The radius of gyration about its other axis shall be taken as that of the uncased section. In computing the axial load carried by the cased strut, the concrete, measured as a rectangular section of mean depth between the flanges of the steel section and width equal to the width of the flanges, shall be taken as assisting in carrying the load, using a modular ratio of 15. The permissible axial load on a cased strut shall not exceed 1·5 times that which would be permitted on the uncased section, nor shall the ratio of slenderness of the uncased section, measured over its full length centre-to-centre of connections, exceed 250. These approximate methods of calculation shall not be applied to struts having an overall section greater than 30 in. by 18 in., the dimension of 30 in. being measured parallel to the web.

PERMITTED LOADS AND TEST RESULTS

The provision resembles that of the 1948 code in limiting the value of the solid casing to 2 in. so that the overall width of the stanchion shall be taken at $b + 4$ and the radius of gyration has still to be taken as $r = 0{\cdot}2\ (b + 4)$. The new feature is that the concrete measured as a rectangular section of mean depth between the flanges of the steel section and width equal to the width of the flanges shall be taken as assisting in carrying the load using a modular ratio of 15. In other words, the small area of concrete contained inside the flanges may be taken into account as load bearing. This permission is, however, as before reduced by the ruling that the permissible load shall not exceed 1·5 times that which would be permitted on the uncased section, nor shall the ratio of slenderness of the uncased section exceed 250. Nevertheless, it does on occasions give considerably greater allowance to the casing than do the provisions of the 1948 standard.

The author was of the opinion that both Standards give inadequate allowance for increased strength of concrete casings under certain circumstances, and he was in particular of the opinion that the concrete casing may have very considerable load bearing value even when the thickness of the casing greatly exceeds the 2 in. which alone is allowed to be taken into account in the two editions of B.S. 449 as at present drafted.

As an example, the accompanying table shows some data related to the full-scale stanchions which were subsequently tested to destruction. The cross-sections of these stanchions are shown

TABLE I.—CALCULATED AND TEST LOADS

Member	Overall size	Length L	Permissible loads			Ultimate load from tests	Factor of safety or load factor on basis of new design method
			Based on B.S. 449/1948	Based on B.S. 449/1955 draft	New basis of design		
	in. × in.	Ft.	Tons	Tons	Tons	Tons	
A1	10 × 6 I Uncased	12	54	54	54	155	2·87
A2	14 × 10 (10 × 6 I)	12	71	81	92	250	2·72
A3	24 × 12 (10 × 6 I)	12	71	81	147	450	3·06
A4	26 × 14 (10 × 6 I)	12	71	81	183	615	3·36
A5	28 × 15 (10 × 6 I)	12	71	81	211	670	3·17
A6	20 × 20 (10 × 6 I)	12	71	81	211	555	2·63
B1	12 × 8 I Uncased	12	111	111	111	273	2·46
B2	16 × 12 (12 × 8 I)	12	125	160	153	430	2·81
B3	24 × 12 (12 × 8 I)	12	125	160	187	420	2·25
B4	26 × 14 (12 × 8 I)	12	125	160	226	676	2·99
B5	28 × 15 (12 × 8 I)	12	125	160	254	870	3·43
B6	20 × 20 (12 × 8 I)	12	125	160	257	870	3·38
C1	12 × 8 I Uncased	18	80	80	80	235	2·94
C2	16 × 12 (12 × 8 I)	18	101	120	124	426	3·44
C3	24 × 12 (12 × 8 I)	18	101	120	152	568	3·74
C4	26 × 14 (12 × 8 I)	18	101	120	192	609	3·17
C5	28 × 15 (12 × 8 I)	18	101	120	218	790	3·62
C6	20 × 20 (12 × 8 I)	18	101	120	232	647	2·79
Preliminary A4	36 × 15 (10 × 6 I)	12	71	81	235	748	3·19

* "Savings to be Effected by the More Rational Design of Cased Stanchions as a Result of Recent Full-sized Tests."

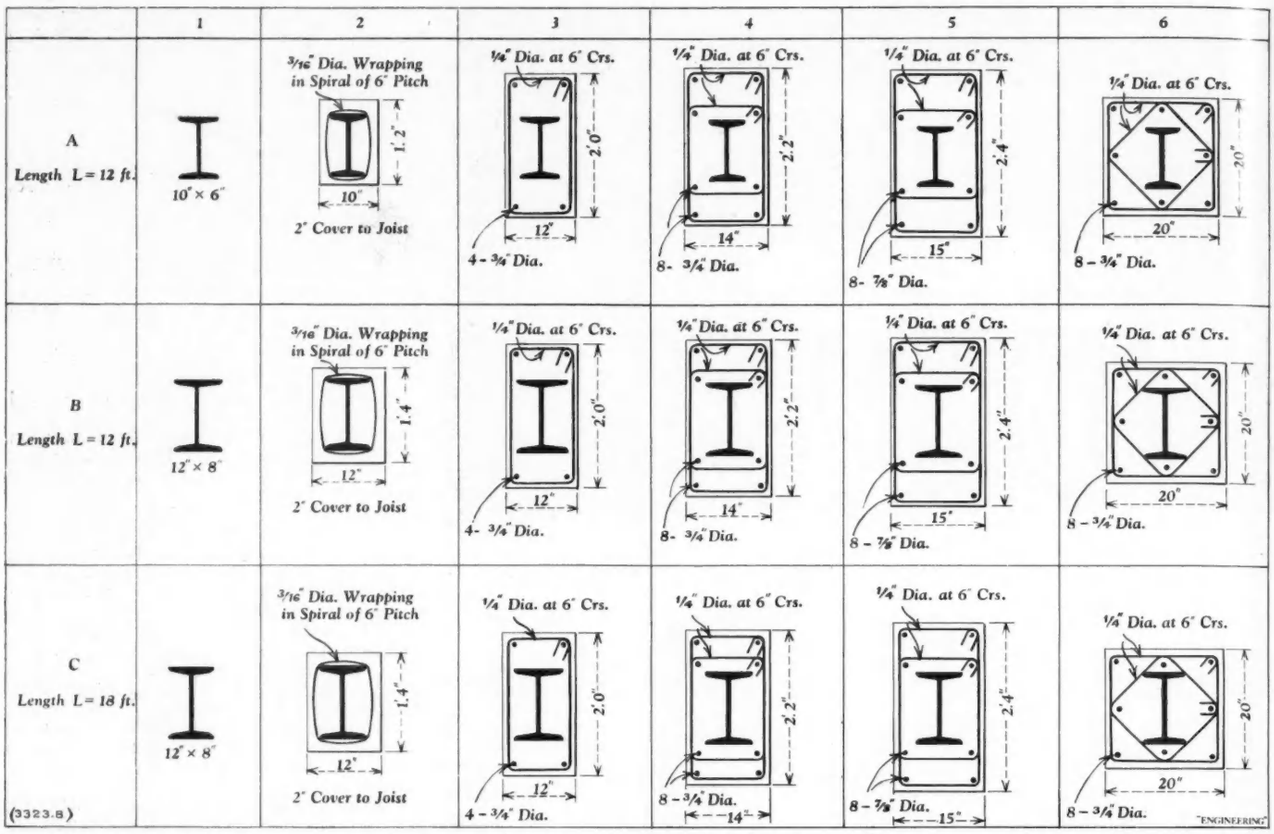

Fig. 2 Cross-sections of the concrete-encased steel stanchions that were loaded to failure in an effort to determine the contribution that could be made by practical concrete casings. The ultimate loads were found to be many times greater than is allowed by the relevant clauses in either B.S. 449-1948 or the draft edition now being circulated, thus indicating that a saving in steel might be effected by the adoption of a more realistic clause such as is proposed in this article.

in Fig. 2. There are 18 stanchions, but if No. C6 is considered, this has the following properties: the casing is 20 in. square, containing a 12 in. by 8 in. joist and the length of the stanchion is 18 ft. 0 in.; the permissible load based on B.S. 449/1948, taking the effective length of the stanchion as 0·85 of the actual length of 18 ft. 0 in., comes to 101 tons. The permissible load calculated in the same way in accordance with the new 1955 draft comes to 120 tons (being, in fact, limited by the rule that it must not exceed by more than 50 per cent. the permissible load on the plain joist) and the permissible load on a new basis proposed by the author, and to be described in greater detail, comes to 232 tons. The full-scale test load on the specimen was 647 tons. From this it would seem that the new basis has an ample margin to justify it.

PROPOSED DESIGN PROCEDURE

The method of calculation advocated is as follow:

Calculate $(18000\ A_s + 760\ A_c)$ lb.

where A_s is the total area of steel plus vertical reinforcements in square inches, and A_c is the total area of concrete in square inches.

Calculate the slenderness ratio accurately as a composite section, taking $m = 15$. Alternatively, as an approximation, take r as 0·2 × least width of casing.

Note.—This approximation gives r less than the true value. Thus, in specimen C6, the true value works out at 4·8 in., while 0·2 × least width equals 4·0 in. In the calculations in this paper the approximate value has been used.

Calculate the safe stress in tons per square inch from Robertsons formula in B.S.499:1955, Table 14 (or in B.S.499:1948, Table 7), and reduce the safe load on the stanchion in the ratio that this figure bears to 9 tons per square inch (the safe stress with no slenderness). This sounds more complicated than it is.

Perhaps an example of the calculation that gave 232 tons for test member C6 would make it easier. Referring to the table on page 855 we have:

Area of 12 in. × 8 in. I, 19·12 sq. in.

Area of small vertical reinforcements to hold the binding, 3·52 sq. in.

Total area of steel, 22·64 sq. in.

Load on steel at 18,000 lb. per square inch, 182 tons.

Area of concrete, 400 − 22·64 square inches of steel = 377 sq. in.

Load on concrete at 760 lb. per square inch, 128 tons.

Maximum load before slenderness reduction, 182 + 128 = 310 tons.

Slenderness ratio, $\frac{l}{r} = \frac{0{\cdot}85 \times 216 \text{ in.}}{0{\cdot}2 \times 20 \text{ in.}} = 46.$

Safe stress from B.S.499:1948, Table 7, corresponding to this slenderness ratio is 6·77 tons per square inch.

Reduction factor, $\frac{6{\cdot}77}{9} = 0{\cdot}75$

Permissible load 310 × 0·75 = 232 tons.

It should be noted that in these calculations the steel stress used is that permitted for mild steel in reinforced concrete (C.P.114) and the concrete stress used corresponds to that permitted for 1 : 2 : 4 concrete under the same Code. The concrete should, therefore, conform to the requirements of the 1 : 2 : 4 concrete in the Code and be good for a crushing resistance in 28 day cubes of 3,500 lb. per square inch in preliminary tests and 3,000 lb. per square inch in works tests.

It is submitted that regulations on these lines would appear to be entirely safe. In the tests to be described the concrete was purposely made not too strong. It was made of one part Portland cement, two parts of coarse sand and four parts of ¾ in. washed gravel from Eldon Quarries, Darlington. No special precautions were taken in the way of vibration and an endeavour was made to produce the kind of concrete which could be expected from an ordinary good builder not attempting to take any special precautions.

TEST SPECIMENS

In October, 1953, the author submitted to a member of the British Constructional Steelwork Association the suggestion that some experiments to verify or otherwise these views might be considered by them and in December, 1953, he submitted a table of proposed test specimens and estimated ultimate loads on the same basis as now advocated. They very kindly agreed to vote a sum of money for the purpose of making the necessary test specimens and let him have the use of the 1,250 ton testing machine in Dorman Long's works at Middlesbrough. This is a very powerful machine and only on a machine of some such size could these full-size tests be properly conducted. One of the stanchions is shown under tests in Fig. 1.

The cross-sections of the test specimens, given in the table and Fig. 2, vary from a plain 10 in. by 6 in. joist 12 ft. long which is progressively encased to give sections 14 in. by 10 in., 24 in. by 12 in., 26 in. by 14 in., 28 in. by 15 in. and 20 in. by 20 in., the "A" series. The "B" series was identical except that the joist was a 12 in. by 8 in. joist and the first casing size was made 16 in. by 12 in. so as to give 2 in. casing to the joist, after which they were increased through the same sizes as before up to 20 in. by 20 in. The "C" series was composed of a 12 in. by 8 in. joist as before, all the cross-sections being the same as in the "B" series, but the lengths of stanchions being increased from 12 ft. to 18 ft.

The larger sizes, from 24 in. by 12 in. upwards, numbers 3, 4, 5 and 6 in each series, were

reinforced with stirrups ¼ in. in diameter at 6 in. centres. The smaller sizes up to 16 in. by 12 in. were reinforced with $\frac{3}{16}$ in. diameter wrapping in a spiral of 6 in. pitch. In calculating the area of steel the area of the vertical rods provided to hold the stirrups accurately in position was taken into account.

TESTING MACHINE

The 1,250 ton machine, constructed by W. and T. Avery, Limited, was provided originally for tests on the members for the Sydney Harbour Bridge. It is 80 ft. long, the specimens being held horizontally, one end supported against a vertical cross-head and the other against a cross-head fitted with a spherical bearing. The spherical bearing is a large one (about 3 ft. in diameter), but it did not behave quite as had been desired and did not appear to give absolutely concentric loading at the end of the stanchion. Apart from this, the testing machine behaved splendidly.

As regards the specimens themselves, the joists were welded to a base plate and cast in the vertical position. The top of the specimen was, however, kept an inch or two down below the top of the joist and then filled up with 2 to 1 sand/cement mortar two days after the concrete casing had been allowed to settle and set so that it finished dead flush with the top of the stanchion. This at any rate was the intention, but in practice it must be admitted that the top surface fell somewhat short of this and some of the specimens had to be ground afterwards prior to being put into the machine.

TESTING

The tests were made in three separate batches at intervals of about a fortnight, all specimens being tested when they were 28 days old and the specimens being cast in three batches so that the shuttering could be used again. The specimens were stored out of doors in the vertical position in which they were cast and the tests were made during the months of September and October of this year.

The cube strengths which were taken and measured with each specimen averaged 4,882 lb. per square inch at 28 days. There is, however, reason to think that these cubes were better punned than some of the concrete in the specimens themselves, as there was evidence of honeycombing in some of the specimens.

Referring to the "A" series, the 10 by 14 cased section failed by buckling, whereas the more massive members failed by crushing of the concrete, some as might be expected near the end, and some near the middle. In the case of the "B" series, there was no evidence of buckling except, of course, of the small reinforcements whose primary function was the fixing in position of the binding and it was perhaps satisfactory to note that failure occurred some at one end, some at the other, and some in the middle. In the case of the "C" series, the smallest member, 16 in. by 12 in. failed by buckling and the remainder by concrete crushing and the buckling of the reinforcing rods provided primarily to fix the binding in position. It was noticed in the case of C4 that although the concrete near the base appeared to be rather porous failure occurred near the top at some considerable distance from the end, but these circumstances did not seem to have much effect on the ultimate load. The foot of B3, after failure at 420 tons, is shown in Fig. 3.

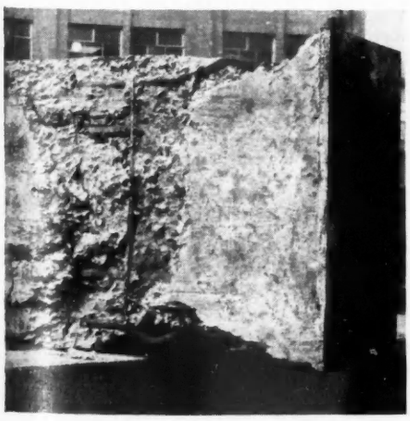

Fig. 3 Column B3, a 12 in. by 8 in. "I" joist in a concrete casing of 24 in. by 12 in., after failing at a load of 420 tons.

Four micrometer gauges were fixed longitudinally along the test specimens on each of the four sides on the two cross-sectional centrelines on a gauge length of 72 in. central along the length of the specimens so as to measure the compression of the member under load.* The strain-measuring arrangements can be discerned in Fig. 1.

From these gauge readings it is possible to make some calculations which, while not perhaps being on the direct line of research as far as the practical value of steel tests is concerned, may be of some interest. For example, for stanchion A5, we find that at 400 tons the average of the compression recorded by the four gauges was 0·058 in.; as this was taken on a 72 in. gauge length we have:

$$\text{Strain} = \frac{0{\cdot}058}{72} = 0{\cdot}00081.$$

Stress = 0·00081 × 13,500 = 11 tons to the square inch.

Load on steel = steel area times steel stress = 16·6 × 11·0 = 183 tons,

whence load on concrete = 400 − 183 = 217 tons.

Area of concrete = 403 square inches,

$$\text{whence concrete stress} = \frac{217 \times T}{408}$$

= 1,200 lb. per square inch.

$$\text{Hence the modular ratio} = \frac{11{\cdot}0 \times T}{1{,}200} = 20{\cdot}5.$$

Similar results have been calculated for many of the other stanchions.

Reference to the curves of the relation between load and compression roughly showed that the bottom half of the curves were straight lines, thus for A5 the curve was straight up to a compression of about 0·06 in. after which it began to bend. The point of the first curvature corresponded to a load of between 300 and 400 tons for the "C" series, which is considerably in excess of the safe load as calculated by the method advocated, indicating that neither in the steel nor in the concrete has anything approaching a yield point been reached at the safe loads indicated by the method of calculation suggested.

DISCUSSION OF RESULTS

In the author's view this research is not only interesting as indicating perhaps more realistically the true increase in strength which can be obtained in a steel column by casing it, but it also suggests a technique under which certain structures could be run up with quite small stanchions designed only to carry the steelwork of the superstructure, and then while the steel above was going up, the concrete casing could rise from the bottom and give the stanchions the strength they will require to carry their full load.

In this way a great saving in steel can be effected and furthermore the drawing office work could be considerably simplified. Thus, a 10 in. by 6 in. stanchion could be provided to carry the load of three or four floors of superstructure, even though the 10 in. × 6 in. was only strong enough to carry something considerably less than the full total load, because the strength of the concrete could be brought into play before the full load has to be carried. In these days when the saving of steel has become a national problem it is thought this conception may have quite considerable merit.

Consideration will have to be given as to how eccentric loading is to be treated with these composite sections. The tests at Middlesbrough gave no information on this matter and some further work will be necessary, certainly mathematical and possibly also experimental. In the meantime, however, the author is of the opinion that eccentric loadings will not usually produce high stresses owing to the enormous increase of the moment of inertia of the composite section.

* Tables of strain readings for each tests and graphs showing the strains against load for some members are included in Dr. Faber's full paper.

PROPOSED CLAUSE

The author suggests that if it be desired to take advantage of this approach and the results of the research, the revised regulation 21b of the new draft Standard might read as follows:

Cased Struts.—Struts of single British Standard I beams to B.S. 4A or British Standard channels back-to-back of symmetrical I-form may be designed as cased struts when the following conditions are fulfilled:

(i) The steel strut is unpainted and solidly encased in ordinary dense concrete with an aggregate not exceeding ¾ in. and with a works strength not less than 3,500 lb. per square inch at 28 days when tested in accordance with B.S. 1881.

(ii) The minimum width of solid casing is equal to $b + 4$ in. where b is the width of the steel flange in inches.

(iii) The surface and edges of the steel strut have a concrete cover of not less than 2 in.

(iv) The casing is effectively reinforced with wire at least $\frac{3}{16}$ in. in diameter in the form of stirrups or binding at not more than 6 in. pitch. When the casing projects outside the steel joist by more than 4 in. the stirrups or binding must be supported by longitudinal spacing bars not less than four in number and not less than 0·8 per cent. of the area of the casing. These rods to be not less than ¾ in. in diameter. The cover to these vertical rods to be 1½ in. The radius of gyration may be taken as 0·2 × B, where B is the least diameter of the cased section. The reinforcements to the casing shall comply with clause 311 of C.P. 114. In computing the axial load carried by the cased strut, the whole of the concrete may be taken into account at a stress of 760 lb. per square inch together with the total area of the steel joist and the longitudinal steel rods stressed to 18,000 lb. per square inch. So as to take into account the effect of slenderness the total load so arrived at is to be reduced by a reduction factor arrived at as follows:

Calculate the slenderness ratio by dividing the effective length of the stanchion by the minimum radius of gyration which may be taken as 0·2 times the minimum diameter of the cased stanchion (or may be calculated accurately as a composite section taking $m = 15$). Ascertain what steel stress corresponds to this slenderness ratio from Table 14 (of the draft specification). This figure, Fa, divided by 9, is the reduction factor previously referred to.

The steel stanchion must be adequate to carry the total reactions from any one floor without assistance from the casing, but it can be assumed that the load represented by these reactions is spread over the whole cross section of the composite column before the floor below is reached.

It will be noted that the author does not propose to retain the clause that says that the permissible axial load on a cased strut shall not exceed 1·5 times that which would be permitted on the uncased section, nor the clause which requires that these methods of calculation shall not be applied to struts having an overall section greater than 30 in. by 18 in. In his view these clauses are without scientific justification and impossible to justify.

CONCLUSION

The short result of this research is to show that composite stanchion construction can be calculated in accordance with the normal rules for reinforced concrete in which the concrete is stressed to 760 lb. per square inch and the steel to 18,000 lb. per square inch under direct load and eccentric loads can be accepted provided they do not raise the stress on the concrete beyond 1,000 lb. per square inch. This is a result which is really not very surprising, but it needed verifying on full-scale tests. It opens up a technique in which a very considerable saving of steel in stanchions can be effected, as well as a considerable saving in money in favourable circumstances. It also makes possible the easy strengthening of stanchions in buildings to which it becomes necessary after construction to provide for additional storeys or loads, subject to the foundations being adequate.

THE ROYAL OBSERVATORY

INSTALLATION OF EQUIPMENT AT HERSTMONCEUX

The annual report of the Astronomer Royal, which this year covers only the eleven months ended on March 31, 1955, gives some further details of the transfer of the Observatory from Greenwich to Herstmonceux, and of the disposal of the major astronomical equipment. Flamsteed's original observatory in the Wren building at Greenwich, together with a number of historic instruments, are to remain in the care of the National Maritime Museum. Among them is the Airy Transit Circle which is to stay in its original position, defining the prime meridian of longitude. Before observations with the Airy Transit Circle were discontinued in 1953, an accurate determination was made of the azimuth of a line between Greenwich and the Meridian Mark at Chingford. This information will go some way to enabling Greenwich to be used as a Laplace station for Ordnance Survey purposes, and will provide an independent check on the astronomical latitude and longitude of Herstmonceux.

The removal of the library from Greenwich to Herstmonceux was completed last year, and considerable progress has been made in the construction of the Meridian and Equatorial groups of buildings at the new observatory, as well as of a new steel-framed building to house the Nautical almanac Office, the Time Department, and the workshops. To Herstmonceux have also been transferred the instruments and equipment of the physics and optics laboratory from the present Magnetic Observatory at Abinger. On account of the disturbing effects of a nearby electrified railway, the Magnetic Observatory is to be removed to Hartland in Devonshire, where building is to be started shortly in order that observations may be begun before the beginning of the International Geophysical Year.* Samples of the building materials to be used have been tested at Abinger to ensure that they are completely non-magnetic. One of the new buildings at Hartland, to be used for testing magnetic instruments, will house a system of large coils designed to provide artificial horizontal and vertical fields comparable with those existing naturally at any point on the earth's surface.

THE SUN'S ECLIPSE

Among the most interesting astronomical work now in progress is a series of observations, by means of the astrographic refractor, of the positions of the four brightest minor planets: Ceres, Pallas, Juno and Vesta. The position of the minor planet Nemausa was also determined on 15 nights in anticipation of a proposed programme of measuring the proper motions of certain variable stars, required for research on galactic structure. The proper motions are expected to be very small, but since the first astrographic plates were taken 50 years ago, it is hoped to attain adequate accuracy by using a large number of comparison stars.

The Astronomer Royal had an impressive experience of the total eclipse of the sun on June 30, 1954, which he witnessed from a Hastings aircraft flying eastwards along the line of totality to the south-west of Iceland. He reports that the symmetrical shape of the corona, and the great length of the equatorial streamers, were very noticeable. The formal expeditions from the Observatory were less fortunate, their views of the eclipse from ground level being in all cases so obscured by cloud that their objectives were not attained. Two small expeditions to Sweden, to make observations of the position of the moon for geodetic purposes, were completely unsuccessful on account of cloud. The main party took a 7 in. telescope to the island of Syd Koster, 10 miles off the Swedish coast near Strömstad. Some views of the diminishing crescent were obtained during the onset of the eclipse, but cloud crossed the field during the totality and no usable star images were secured although the typical "minimum" corona was clearly seen. The resulting photographs proved to be severely fogged by coronal light scattered in the cloud and only the bright stars near the edge of the field produced visible images on the plates, so that no data were obtained for studying the gravitational deflection of starlight by the mass of the sun. The photograph taken during totality exhibits remarkably symmetrical equatorial streamers extending to more than four radii from the boundary of the sun's obscured disc. These long streamers were sharply differentiated from the short polar plumes that border the sun's limb at latitudes above 60 deg. The eclipse occurred at the exact epoch of minimum solar activity, when there were no sun spots, so that the corona was unusually free from the disturbances which occur when sun spots are present. The axis of symmetry of the elongated streamers was normal to the direction of the sun's axis of rotation. If the exactness of this coincidence is not a chance effect, it may be inferred that the outer coronal regions are under the control of the sun rotating deep within them.

* See ENGINEERING vol. 180, page 296 (September 2, 1955).

SUNSPOT OCCURRENCE

Routine photographs of the sun, taken with the photoheliograph at the Observatory, were obtained on 273 days during the eleven months covered by the Report. The mean daily sunspot number throughout this period was only 8, as compared with 10 for the preceding year. There were 164 spotless days, the sun being almost completely free from spots during May and June of 1954. By the beginning of 1955 the passing of the minimum sunspot epoque was quite apparent from the almost complete cessation of the low-latitude spots of the previous cycle. The largest of the new cycle spots, rising to a maximum area of 800 millionths of the sun's hemisphere, crossed the central meridian in latitude 36 deg. north on January 13 last. It was probably related to a moderately intense solar flare which was detected shortly after midday on January 10 by a radio recording receiver working on 27 Kc/s. The relative extents to which spots occur on the northern and southern hemispheres of the sun is a matter of some interest that has recently been investigated by reviewing the observations of sunspot area taken at Greenwich over the 80 years between 1874 and 1954. The results showed a progressive change of pattern which, at first sight, appeared to be periodic. Examination of earlier records, going back to 1832, does not confirm this suggestion of periodicity, but the progressive change of pattern may have some unknown significance and is to be given further study.

TIME SIGNALS

The Observatory time service, of which the headquarters is at Abinger, has been continued, along the usual lines, by star observations with transit instruments at Abinger and Greenwich, and by quartz oscillator clocks which control the radio time signals. The determinations of time are corrected for the effects of the earth's polar motion, based on current latitude observations communicated regularly by the United States Naval Observatory. The star observations for time have been compared with the records of selected quartz clocks in order to derive the apparent annual fluctuation in the rotation of the earth. The analysed results reveal no significant change during the past year in the previously observed amplitude and phase.

Among the quartz clocks at Abinger, the best performances have been given by two that embody ring crystals. The subsidiary standard clocks, employing GT-cut plate crystals, which are used to control the time-signal transmitting equipment, are proving insufficiently uniform to be adequate for modern requirements. One of the primary standard ring-crystal oscillators has therefore been in use for controlling time-signal transmitting equipment. The GT-cut plate oscillators at Greenwich have, in the past, suffered from fluctuations in the mains voltage, and a voltage stabiliser has accordingly been installed in the supply system. At Abinger, three oscillators of a pattern developed in the Observatory Electronics Laboratory are undergoing experimental investigation. As an alternative to the employment of a condenser in series with a crystal to bring the frequency of an oscillator near to its nominal value, the use of a continuous phase-shifting device is being considered and tests are in progress on a model incorporating a motor-driven phase-shift capacitor. The possible advantages of employing transistors in quartz clock circuits are also under investigation. Since these crystal resonators are susceptible to temperature change they must, for the requisite high accuracy, be operated inside thermostatically controlled ovens or chambers. Some new equipment for precisely measuring these controlled temperatures has recently been installed, and has shown that the temperature variations in the latest type of oven do not exceed 0·001 deg. C. in the course of a month.

As the outcome of the time service, the international radio time signals, the "six pips," and the hourly signals used by the Post office for the telephone "speaking clock," have all been sent out during the year under the control of the phonic motor transmitters at Abinger. At Greenwich, where a reserve service of hourly and "six-pips" signals has been available if required, the Time Ball has also been dropped daily except on three occasions when high wind or snow prevented the ball from being raised. For the convenience of observers of the solar eclipse on June 30, 1954, special series of time signals were broadcast between 09·00 hours and 15·00 hours by the Post Office long-wave transmitter at Rugby and by associated short-wave transmitters.

MAGNETIC VARIATIONS

The Observatory at Abinger has, as usual, maintained an unbroken photographic record, throughout the year, of the declination, horizontal intensity and vertical intensity of the earth's magnetic field. The mean annual values of all the magnetic elements, estimated for the year 1955, are presented in the following table along with the values for the four previous years.

Year	Declination (West)	Horizontal Intensity	Vertical Intensity	Inclination
	Deg. Min.			*Deg. Min.*
1951	9 12·2	0·18648	0·43305	66 42·1
1952	9 4·7	0·18671	0·43316	66 40·9
1953	8 57·5	0·18697	0·43321	66 39·3
1954	8 50·9	0·18722	0·43332	66 38·0
1955	8 44·1	0·18746	0·43342	66 36·7

In each case the latest values continue the regular trends of variation previously established. The necessary overlap in observations between Abinger and the new magnetic station at Hartland is to be carried out during the International Geophysical Year, which ends in December, 1958. Thereafter all magnetic work at Abinger will be discontinued.

GEOPHYSICAL YEAR

Meanwhile, preparations and trials of the programmes and methods proposed for the International Geophysical Year are actively in hand in all the departments concerned. As far as possible, the sun will be kept under continuous observation, additional measurements and photographs being taken during periods when special solar activity is expected. These periods, lasting for perhaps three or four days, will be known as Special World Intervals, and will be announced by a central forecasting agency equipped for solar observations. The photographic zenith tube will be used at Herstmonceux in connection with the world programme of longitude and latitude determinations. It is proposed to obtain an impersonal prismatic astrolabe for the observations at Greenwich;

each of these instruments enables time and the variation of latitude to be determined free from personal equations, so that Herstmonceux and Greenwich will both be tied into the world network with high accuracy.

Seasonal changes in the earth's rate of rotation and polar movements are known to depend on the general circulation of the atmosphere. During the International Geophysical Year information on these subjects will be derived from many stations at various altitudes, and the simultaneous data so obtained should enable a closer evaluation to be made of the relationships among these phenomena. Similarly, the times of reception, at a number of different points throughout the world, of radio time signals is expected to furnish information about the speeds of travel of radio waves of long and short wavelengths, and of the dependence of those speeds upon ionospheric conditions.

ISAAC NEWTON TELESCOPE

The Astronomer Royal includes in his report some particulars of the progress made in the design of the new 98 in. Isaac Newton telescope,* for which the glass disc continues under observation at the works of the makers, Sir Howard Grubb, Parsons and Company. Tests of the figure were carried out in August, 1954, during the works holiday when there were no disturbances from vibrating machinery. These observations were conducted from a staging above the mirror, which was laid horizontally on a supporting air bag so as to be free from strain. The figure was found to be almost entirely free from astigmatism, but exhibited some differences from earlier tests made with the mirror vertical. The makers have suggested that the change of figure may have been the result of gradual release of residual strains left in the glass as a consequence of the grinding and polishing operations. Although the Astronomer Royal considers that this is inherently improbable, the mirror has been put aside for future testing after the lapse of enough time for any further release of strain to become evident from optical studies of the figure.

The construction of the mechanical parts of the telescope will take some years yet. The present state of development is that a study design contract has been placed with Sir Howard Grubb, Parsons and Company, who have appointed a committee to discuss details of the mechanical and optical design. The method of structural stiffening, proposed for the telescope tube by Mr. B. N. Wallis, has been tested by means of a model made by the Engineering Laboratory of Cambridge University. Several variants of the main principle are still under consideration to determine the most stable and sensitive arrangement, but the apparatus has already demonstrated that the changes of length of a steel tube under stress can be reduced by this method to less than one-eighth of those of the simple tube.

* See ENGINEERING, vol. 179, page 418 (April 1, 1955).

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250 WATT COLOUR-CORRECTED LAMP

The General Electric Company, Limited, Kingsway, London, W.C.2, are extending their range of colour-corrected mercury fluorescent lamps by a new unit rated at 250 watts. It will be similar in appearance to the existing 400 watt lamp and will have the same colour-rendering properties. It will be possible to operate it with the standard 250 watt control gear.

The average light output of the new lamp is 9,250 lumens. This is nearly 20 per cent. higher than that of the existing vertical burning 250 watt mercury lamp with a glass envelope and a loading of 10 watts per centimetre of arc length. The two lamps are fully interchangeable.

Because of its good colour rendering the new lamp will be offered for interior as well as exterior lighting. It will be available from January 1, 1956.

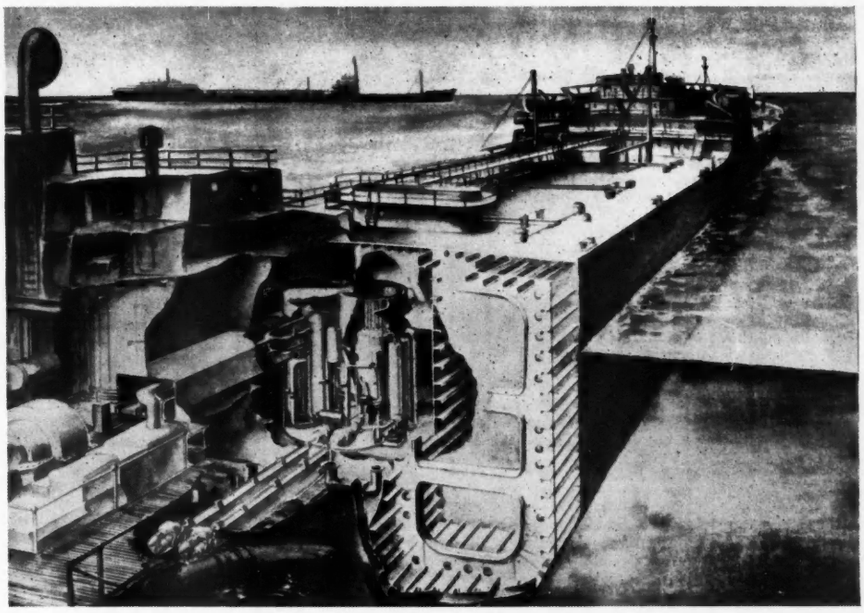

Fig. 1 Impression of nuclear power plant installed in an ocean-going tanker; although a pressurised-water reactor is shown, gas cooling may prove more economic. It appears that for high powered vessels running on long hauls the use of nuclear power for propulsion will be competitive with conventional fuels.

PROPELLING SHIPS BY NUCLEAR POWER

DIRECT USE OF REACTOR COOLANT IN GAS TURBINE

The development of nuclear power for propulsion has most immediate prospect of success in ships, since the size of reactors and the weight of their shielding at present prohibits their ready use in other forms of transport, such as aircraft and road vehicles. Nevertheless, even the marine application of nuclear energy presents formidable problems, both technical and economic, and a paper dealing with this subject entitled "Nuclear Power for Commercial Vessels" has recently been presented before the Institute of Marine Engineers, 85 The Minories, London, E.C.3. After selecting the gas-cooled reactor as the most suitable for marine propulsion, the author, Mr. K. Maddocks, B.Sc.Tech., A.M.I.Mar.E., described a proposed closed-cycle gas-turbine plant supplied from a helium-cooled reactor, and then compared economically the operation of a cargo vessel as powered by a nuclear reactor and by an oil-fired steam-turbine plant. There is an apparent paradox in the choice of an oil tanker for this analysis since it is reasonable to expect that oil and nuclear power will one day be competitive. Comment was also made on the two American nuclear-powered submarines. The paper, which was delivered on December 20, and will also be read before the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2, on December 29, is summarised below.*

FEASIBLE MARINE REACTORS

Among the reactor systems which might be considered for marine use are the following: (1) pressurised-water reactor (*Fig.* 6); (2) boiling-water reactor (*Figs.* 10 *and* 11); (3) homogeneous reactor (*Fig.* 8); (4) sodium-loop reactor (*Fig.* 13); and the gas-cooled reactor (*Fig.* 1). (The italicised Fig. numbers refer to drawings in an article on page 490 of the October 7 issue of ENGINEERING.)

Perhaps the main advantage of the pressurised-water reactor is that the expansion of water with temperature rise permits an increased leakage of neutrons and hence the reactor is to some degree self-stabilised. A serious disadvantage is the impracticability of producing superheated steam. The pressurised-water reactor has, however, been used successfully in the American submarine U.S.S. Nautilus, the pioneer reactor-driven vessel. The boiling-water reactor, which is similar but with the secondary circuit eliminated, has two additional disadvantages.

* Assistant Professor of Marine Engineering at the University of Michigan, Ann Arbor, U.S.A.

First, during the boiling process, the variation in density of the water, which acts both as working fluid and moderator, allows variation in neutron leakage, thus causing a fluctuation in reactor power level; and secondly, the steam leaving the reactor is radioactive, thus providing a further shielding problem. It seems likely, therefore, that the boiling-water reactor would be operated at a lower power level than the pressurised-water reactor.

The characteristics of the homogeneous reactor might be summarised by stating that nuclear stability or safety is purchased at the expense of providing a completely leak-proof system for a highly radioactive and corrosive solution subject to a pressure of at least 1,000 lb. per square inch.

SUBMARINE "SEA-WOLF"

The sodium-loop reactor is a variant in heterogeneous-reactor design using liquid sodium as coolant, and a version of this system is to be used on a second nuclear powered submarine U.S.S. Sea-Wolf. Since sodium is a weak moderating material, a separate moderator will be required and this could be of graphite-block construction similar to the original piles at Harwell and elsewhere. For ship-board use, the quantity of moderating medium can be considerably reduced by designing the reactor for operating at an energy level above the "thermal." Sodium at atmospheric pressure has a boiling point of 1,600 deg. F.; consequently, the upper reactor temperature is not controlled by system pressure, and large temperature variations in coolant can be arranged. While this leads to design difficulties arising from thermal stressing, it also overcomes one of the main application problems by allowing the production of moderately superheated steam (say, 600 lb. per square inch and 800 deg. F.).

The higher level of the reactor power output increases the degree of radioactivity in the sodium and this provides a more difficult shielding problem than is encountered in a thermal reactor. Also, the preparation of a sodium-cooled reactor for operation must include arrangements for external melting of the material prior to circulation in the system. In fact, an auxiliary oil-fired boiler will be required for this purpose.

Another major potential danger is the possibility of leakage if the highly radioactive and strongly alkaline sodium were in close proximity to the steam system. Any such leakage would produce a violent reaction with water. Thus, the coolant system is

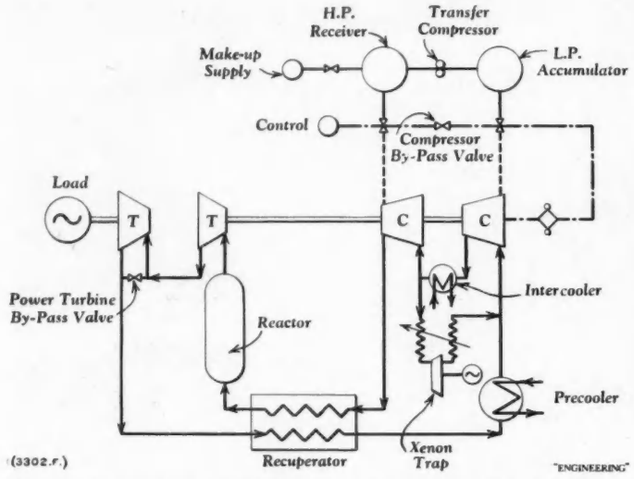

Fig. 2 Closed-cycle gas-turbine plant. The gas-cooled reactor offers a favourable balance between first and operating costs and simplicity and safety in operation, but its main advantage is the direct use of the reactor coolant in a gas turbine; secondary steam plant is therefore eliminated.

separated into two stages to provide a partial solution. In the primary heat exchanger, the radioactive sodium from the core gives up heat to non-radioactive sodium which is then used to heat the secondary heat exchanger or steam generator.

BENZINE AS WORKING FLUID

Another method of safeguarding against the contact of liquid sodium and water is the use of double-wall concentric tubing in the secondary heat exchanger. The annulus of this tubing could be filled, say, with lead, giving a good heat-transfer bond and a leak-detecting medium.

A further suggestion is the use of benzine as working fluid to replace steam. Benzine is chemically inert with sodium, and the danger of a violent reaction resulting from any leakage is therefore eliminated. It seems probable, however, that the use of benzine would not find favour in the marine field on account of the fire hazard introduced.

Probably the major engineering problem to be faced with this system is the pumping of a liquid metal at a temperature of about 1,000 deg. F. Any leakage would produce both a radioactive and a fire hazard. A typical specification for leakage tolerance is one cubic centimetre in ten years and to perform this onerous service two types of pump have been developed. One is an electromagnetic pump which requires no rotor and, consequently, no shaft glands; it is reliable but its efficiency is low. The other type is a centrifugal pump using fluid bearings. This has a much higher capacity, but is subject to the usual mechanical failures.

HELIUM COOLING : POWDERED FUEL

Of the five reactor systems listed the author considers that the familiar gas-cooled plant in its marine form described later offers the most favourable balance between first and operating costs and simplicity and safety in operation. Preliminary designs and outlines of equipment have been prepared for a submarine installation to compare the use of water, sodium and helium as coolants in the nuclear power plant; the table below summarises the analysis made.

TABLE.—*Comparison of Water, Sodium and Helium as Coolants*

Date of Plant	Water	Sodium	Helium
Shaft power output	0·90	1	1
Overall plant weight	0·97	1	0·64
Specific weight (lb. per s.h.p.)	1·08	1	0·64
Space occupied (cub. ft. per s.h.p.)	1·10	1	0·66
Shield weight	0·77	1	0·51

While these figures appear to favour the use of helium, their validity awaits the results of considerable development work to confirm a number of assumed factors.

There is also the possibility of using fuel in powdered form sealed in a metal container, thereby reducing fuel re-processing costs, although this could introduce a danger of failure of the fuel elements during operation. The moderator is provided in the form of block graphite or beryllium oxide and the control rods could be of boron steel or cadmium.

Although the author does not envisage shipboard use of the breeder reactor, he considers that it will play a part in marine development as the source of a cheaper fuel than mined uranium.

CLOSED-CYCLE GAS TURBINE

The heat energy in the gas from the reactor can be converted directly into mechanical work in a closed-cycle gas turbine, and while the working fluid could be air, nitrogen, carbon-dioxide or helium, the latter is preferred. The steam generating and condensing equipment is thus eliminated, together with make-up feed, boiler water conditioning and many other ancillary problems connected with modern steam plant.

The closed-cycle gas turbine has been under development in Switzerland for 16 years, and all the machines so far put into service have operated on air, the maximum output of any one set being 12,500 kW. Nitrogen, which comprises 77 per cent. of air, has very similar characteristics. Carbon dioxide has better heat-transfer properties, but all three become radioactive when heated in a nuclear reactor. Helium, however, if kept free of slight contamination during circulation has a nucleus which is very stable under neutron flux, and thus does not become radioactive. It follows that in this type of plant, only the reactor requires shielding, allowing a far more flexible machinery arrangement and a considerable saving in weight.

LEAK-PROOF SYSTEM

Helium has a better heat-transfer characteristic than nitrogen, and this is enhanced with increasing pressure. Thus, the heat-transfer surface required will be less than in an air or nitrogen system, but the high specific heat of helium makes the design of turbine machinery more difficult. The number of stages required for the same temperature rise is roughly proportional to the specific heat (1·25 B.Th.U. per lb. for helium compared with 0·24 B.Th.U. per lb. for air). However, cycle analysis shows that the compressor temperature ratio required for maximum cycle efficiency decreases with increasing recuperator effectiveness; this fact is applied in the design of closed-cycle helium plant by exchanging static heat-transfer surface for stages of turbine machinery. The inert helium also excludes the problem of chemical attack on the power-plant components. The use of helium has one major fault —its cost. To minimise this expense, a leak-proof system is necessary.

Fig. 2 is a diagrammatic representation of the suggested plant. Expansion is in two stages to isolate the power turbine from the compressor drive. Reversing can be accomplished either by a reversible-pitch propeller—although the upper limit of power which could be absorbed by the propeller may not be compatible with the minimum power required for an effective nuclear plant—or, the power turbine can be built as a reversible inward-flow radial machine; or a turbo-electric drive could be adopted.* A typical axial-flow turbine suitable for an output of about 20,000 s.h.p. is shown in Fig. 3. One of the most pressing engineering problems in producing a gas-tight system is the design of a suitable turbine gland. The heat-transfer surface in the recuperator and precooler could be of the plate fin type, and the intercooler of shell and U-tube pattern.

CONTROL BY WITHDRAWING HELIUM

The power output of the plant varies with the system pressure. This pressure-level control is effected by addition or withdrawal of working fluid from the circuit, and emergency speed control of the power turbine is effected by use of a by-pass. Helium that is not being circulated in the plant is stored in accumulators for subsequent use as indicated in Fig. 2, making this a no-loss system. The accumulator set consists of two (or two groups of) storage bottles, one being the receiver and the other the accumulator interconnected by a transfer pump. In this system, the total amount of helium in the power plant and tanks is constant at all times. Any leakage loss is made good by addition of helium to the receiver from time to time as required. Manual control of valves between the system and the receiver and accumulator tanks allows the selection of any desired pressure level.

An overspeed governor is provided on both the high-pressure compressor-turbine set and the power turbine. The governor on the compressor-turbine set is a top-speed governor only, tripping a compressor by-pass valve when this set exceeds a predetermined speed limit. The governor on the power turbine is designed to come into play only in the event of an emergency the occurrence of which makes it necessary to shut down the plant. In action, the power-turbine governor opens the power-turbine by-pass valve, immediately reducing the helium flow through the power turbine. Since this reduces the back pressure on the compressor drive turbine, it tends to overspeed, thus actuating the compressor by-pass

* A hydraulic marine reversing transmission developed by Pametrada was described on page 567 of the issue of ENGINEERING of October 21, 1955.

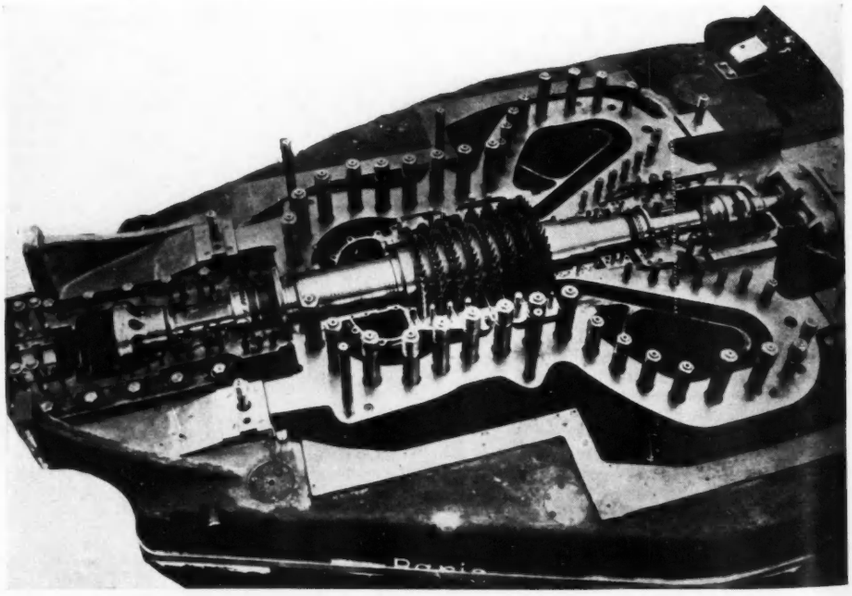

Fig. 3 Axial-flow turbine suitable for use with helium as working fluid. Helium has advantages over water and sodium for reactor cooling, both in terms of plant weight and volume, and power output; it is chemically inert, has good heat-transfer properties and does not become radioactive. A closed-cycle reactor-turbine system can be controlled by varying the quantity of helium in the circuit.

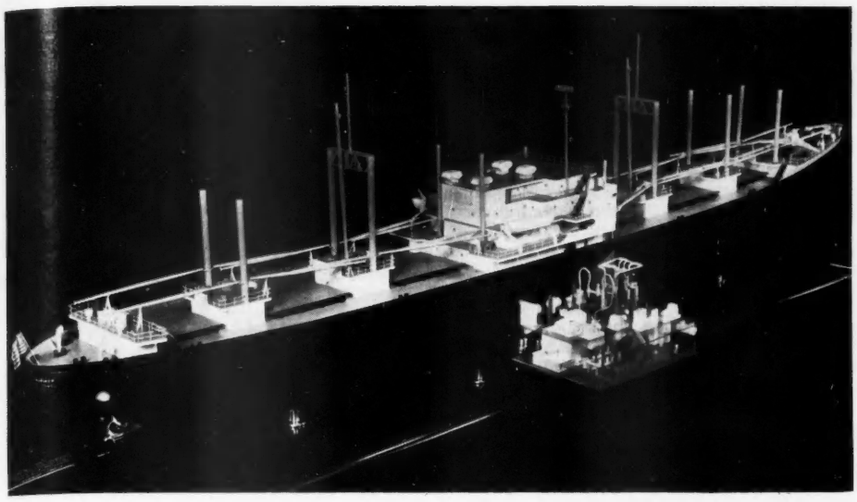

Fig. 4 Model of proposed nuclear powered vessel, the "Atomic Mariner." Bulk cargoes such as metallic ores, grain and oil are likely to be most suitable for carriage in nuclear powered ships. Conditions in Europe are more favourable for the application of atomic energy to marine propulsion than in America.

valve. Further, the power turbine overspeed governor trips the system pressure regulator, resulting in the discharge of the contents of the system to the receiver. Simultaneously, the control rods are dropped into the reactor, reducing the heat input to the system.

REMOVING RADIOACTIVE XENON

When the power-plant load is eliminated and the reactor activity level reduced, a means must be provided to cool the reactor for a period after shutdown. During both the normal procedure of shutting off the plant and the emergency condition previously discussed, the compressor-turbine set circulates helium through the reactor until the minimum self-running speed is reached. At that time, a secondary, motor-driven circulating compressor with an auxiliary cooling loop is energised, circulating helium through the reactor until activity is sufficiently reduced to give a safe temperature level.

Helium suitable for use in such a plant is available commercially at a purity of 99·99 per cent. Impurities consist of argon, carbon dioxide and nitrogen, none of which is in sufficient quantity to be of concern. There is, however, the possibility of contamination of the system by gaseous fission products escaping from the reactor fuel elements. The principal volatile radioactive impurity of the fission process is xenon, but this can be effectively removed to any degree desired by solidification in a cold trap, so preventing even a small build-up of radioactivity in the working fluid.

ECONOMICS OF NUCLEAR PROPULSION

A power of 15,000 s.h.p. has been given as a minimum to exploit fully the advantages of using nuclear fuel. It is worth noting in this respect (*a*) that as the amount of shielding is practically independent of power output, a nuclear power plant of low power will be penalised excessively with regard to its power output; and (*b*) that power plants for propulsion of larger ocean-going vessels (of the order of 10,000 h.p. and above) are of sufficiently high power output to fall within the favourable range for a nuclear power plant of current design.

High Powered Cargo Ship.—An economic analysis has been made of the application of nuclear power to the Mariner class ships. These cargo vessels have a displacement of 21,000 tons and develop 17,500 s.h.p. to give a cruising speed of 20 knots. The maximum output is 19,250 s.h.p. and is, therefore, within the range considered feasible for nuclear powering. The design study has not, however, been published. It is presumed that a sodium loop reactor would be used to provide steam of sufficiently high superheat. Fig. 4 shows the model of this projected ship, the Atomic Mariner.

HIGH POWERS: LONG HAULS

The conclusion reached from the economic analysis of a nuclear-powered Mariner was that it could not compete with the conventional power plants at present, but that advances in reactor technology would improve the competitive position of this new power source. One factor which will adversely affect the suitability of this class of vessel for nuclear propulsion is its relatively low "load factor," determined from the number of days at sea and the power developed. One report assumed 170 days at sea at 10,000 s.h.p. as typical for these ships. This gives a load factor of

$$\frac{10{,}000}{17{,}500} \times \frac{170}{365} = 26{\cdot}6 \text{ per cent.}$$

The deficiency applies in some degree to all types of general cargo carrier.

Bulk Cargo Carriers.—A survey of the most desirable conditions under which to operate a nuclear-powered vessel gives a good indication of the type of vessel most likely to benefit from its adoption. As a first requirement, a high powered installation running on a long haul fully exploits the saving in oil fuel. Intermittent operation of a nuclear reactor is a wasteful procedure, as at reduced loads it will probably be necessary to make arrangements for "dumping" the temporarily unused heat. Even on shutdowns, the reactor output can only be gradually reduced to prevent overheating. Thus, in both cases a waste of valuable fissile fuel can occur. To minimise this loss, berthing and cargo handling time must be reduced.

BULK CARGOES

Another consideration is the special terminal facilities necessary to handle radioactive material. A shuttle service with fixed terminal ports would thus be desirable. Bulk cargoes such as ore, grain, or oil are therefore indicated and the latter appears to be preferred, particularly as the offshore loading and discharge of oil cargoes is now an accomplished fact. This is an additional advantage both in reducing manoeuvring time and in providing a safety measure by isolation. The choice of an oil tanker is not a paradox as it is inconceivable that the use of nuclear energy will reduce the demand for oil within a period of time equivalent to the combined lives of several ships.

Calculations have been made for a 30,000 ton tanker of 16,500 s.h.p. powered by a helium-cooled reactor and a closed-circuit gas turbine, and steaming on a regular run of 10,000 nautical miles each way (from a North European port to the Burma or Borneo oilfields, for example). For such a vessel to break even with an equivalent orthodox steam-powered tanker, the cost of uranium 235 must be £8 10s. per gram. At the International Conference on the Peaceful Uses of Atomic Energy held in Geneva last August, the price of uranium 235 was quoted at 25·00 dols. per gram. Even allowing for some error in this figure, with the present rate of exchange at 2·80 dols. to £1, it would appear that a balance in "steaming costs" for the two plants could very nearly be made.

Other considerations are that bunker fuel capacity of this 30,000 ton deadweight tanker is 4,500 tons and would be filled at the port of loading; and that using a nuclear powered plant would increase the machinery weight by some 500 tons, giving a net increase in cargo capacity of 4,000 tons.

PLANT AND FUEL VERSUS PAYLOAD

Another estimate was based on a 20,000 s.h.p. nuclear powered tanker with a service speed of 18 knots and a cargo capacity of 35,000 tons, making eight voyages of 17,000 miles per year; the type of reactor was not specified but steam was to be used as the thermodynamic fluid. The conclusions were that on a straight economic basis the vessel would not be competitive with a conventional-fuel burning tanker; but that if the costs for the two kinds of plant were to be equal then (*a*) with zero nuclear fuel cost, the maximum permissible price for the reactor plant would be 4,800,000 dols. and (*b*) assuming zero investment in the plant, the nuclear fuel price could not exceed 27·80 dols per gram. However, it was considered that a saving would be made in the combined weight of plant and fuel, and that every 1,000 tons of additional cargo capacity could pay for a further plant investment of 500,000 dols.

A further proposal has been made by the Engineering Research Institute of the University of Michigan. This is included in a recently completed feasibility and preliminary design study for a nuclear power plant suitable for a large ocean-going tanker. An artist's impression of this installation is shown in Fig. 1. Once more it was found that there would be no saving in operational cost compared with an oil-fired installation, but this was probably because the specification called for a tried type of reactor; a pressurised-water reactor was selected.

EUROPEAN VIEWPOINT

Perhaps a more significant comment for immediate interest is that these figures, and the conclusion drawn from them, apply to an American-operated vessel. The equivalent European ship would have a considerably reduced ship operating cost, many items of which would be at least halved. This means that the cost of the machinery and fuel forms a larger part of the European ship operating cost. Hence, the balance would be more in favour of the nuclear power plant if compared with the oil-fired plant when using figures applicable to a European ship. This would be particularly true when items of plant and components became available on a normal production basis.

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FOSTERING ENGINEERING ABILITY

Vickers-Armstrongs' New Apprentice Training School

Opening a new apprentice training school at Vickers-Armstrongs (Aircraft), Limited, Weybridge, recently, the Minister of Supply, Mr. Reginald Maudling, said that the achievement of Vickers-Armstrongs in breaking into the American domestic air-line market with the Viscount was remarkable in view of the superior technical and research facilities and manpower resources of the United States aircraft industry. Great Britain, he said, had built up her industrial strength mainly on coal and brain-power. The supply of coal was now dwindling, and it was therefore of the greatest importance that the scientific and technological abilities of the United Kingdom should be fully developed. In the engineering field particularly, Great Britain was in danger of falling behind the United States and the U.S.S.R. For this reason he welcomed the extension to Vickers-Armstrongs apprentice training facilities.

The apprenticeship scheme at Vickers-Armstrongs has in fact "come of age" this year. In 1934, when it was introduced, there were 30 boys under training. By the end of 1950, the number had increased to 230 and to-day there are more than 700 apprentices under training at Weybridge. The new facilities include a comprehensive training machine shop, in which the boys spend their first eight months before passing into the various shops in the factory. The building also houses a large lecture hall, which can be divided into three lecture rooms by sliding partitions, as well as a projection room, students' common room and library.

Three grades of apprentice are trained at Weybridge—trade apprentices, entering at 16, who undergo a five-year course in a particular trade; engineer apprentices, who are prepared for the Higher National Certificate examination; and student apprentices, who are selected as potential graduates and who generally do a "sandwich" course, dividing their time between periods in the works and at the university. In addition, post-graduate trainees are given a two-year practical course.

The Iron and Steel Institute Autumn Meeting in London (*continued from page* 830)

IRON UNDER INVESTIGATION

STRAIN-AGEING AND DEOXIDATION INCLUSIONS

Continuing our report of the annual autumn general meeting of the Iron and Steel Institute, held in London on November 16 and 17, we now deal with the proceedings on the morning of the second day. The first half of the session was devoted to the discussion of two papers on the strain-ageing of iron, and the second half to a consideration of two papers relating to the microscopical examination of samples of iron containing siliceous and titanium-bearing inclusions.

STRAIN-AGEING OF IRON

The first paper on strain-ageing was entitled "The Strain-Ageing of Alpha Iron." It was by Dr. W. R. Thomas and Dr. G. M. Leak, of the Metallurgy (General) Division of the British Iron and Steel Research Association, Sheffield. The authors stated that they had measured the rates of strain-ageing of specimens of α-iron containing carbon, and α-iron containing nitrogen at various temperatures. Activation energies for strain-ageing had been estimated as 20·4 kcal./mole for carbon and 18 kcal./mole for nitrogen, values in close agreement with the respective activation energies for diffusion of these solutes in α-iron. The rates of strain-ageing agreed with the $t^{\frac{1}{3}}$ law of Cottrell and Bilby up to 50-60 per cent. completion of the process. It had been found that the number of dislocations introduced into a freshly-quenched specimen by a given strain was dependent on the number of solute atoms.

Calculations of the density of the dislocation atmospheres gave 10-15 atoms per atom plane of dislocation. This confirmed the suggestion of other investigators that precipitation was likely to occur.

The second paper, entitled "The Strain-Ageing of Pure Iron," was by Dr. Brynmor Jones and Mr. R. A. Owen-Barnett, of the Whitehead Iron and Steel Company, Limited, Newport, Monmouthshire. They stated that they had investigated the ageing characteristics of two samples of pure iron containing less than 0·004 per cent. of carbon and 0·002 per cent. of nitrogen after temper-rolling and after tensile-straining. As a result of these treatments the irons showed an appreciable degree of strain-ageing that was almost equivalent to that of open-hearth mild steel. After temper-rolling, the rate of ageing of pure iron was more rapid than was the case with commercial steels and had been found to be complete within one month. It was then equivalent to the strain-ageing that occurred on heating to 75-250 deg. C. In contrast, the ageing of mild steel developed progressively over a period of years. The rapid ageing of pure iron had been explained by the ease of migration of carbon and nitrogen atoms in the α-iron lattice. The strain-ageing of iron was eliminated by annealing in moist hydrogen, which reduced the carbon and nitrogen contents to almost zero values.

EFFECT OF CARBON AND NITROGEN

Dr. B. A. Bilby, in opening the discussion, said that the paper by Dr. Thomas and Dr. Leak was a valuable contribution to knowledge, particularly in view of the careful attempt made by the authors to separate the effects of carbon on the one hand and those of nitrogen on the other.

Dr. Brynmor Jones said that the rates of strain-ageing after tensile straining had been determined at various temperatures between 24 deg. and 67 deg. C. The estimated activation energies for strain-ageing confirmed the results obtained by previous research workers; for example, C. A. Wert in 1950, in some work published in the *Journal of Applied Physics* of that year, had found that the activation energy of carbon in iron was 20·1 kcal./mole and the activation energy for the diffusion of nitrogen was 18·2 kcal./mole, against 20·4 and 18·0, respectively, found by the present authors, which constituted very close agreements.

In both the papers now under discussion, the basic material was pure iron. Perhaps that was a wrong name to give it, because there was no such thing as pure iron; some irons were purer than others. It would be better to say "high-purity iron," and even that referred to the iron before hydrogen treatment. As it had been shown that the small amounts of carbon and nitrogen in these irons caused appreciable strain-ageing, it would have been of great interest to find the individual effects of these small amounts of these elements; namely, the relative effects, on strain-ageing, of 0·003 per cent. carbon in the absence of nitrogen, and of 0·0014 per cent. of nitrogen in the absence of carbon.

DENITROGENISING STEELS

The difference between the effects of carbon and nitrogen almost certainly depended on the difference in the solubilities of these elements in iron. In the nitrogen-bearing irons, the ageing tests had been carried out on iron containing 0·015 per cent. and 0·029 per cent. of nitrogen. Those who were in the steel trade knew that these were very large amounts indeed, and much greater than were present even in high-nitrogen Bessemer steels. In point of fact such steels would require denitrogenising to make them usable for many purposes. Steels made both by the open-hearth and by modern improved Bessemer processes contained less than 0·006 per cent. of nitrogen. It was appreciated that it might be of interest to consider the effects of similar amounts of nitrogen and carbon, such as 0·015 per cent. of each, but it was generally accepted that this amount of nitrogen had a more drastic effect on strain-ageing and other properties than a similar amount of carbon would have.

Dr. B. B. Hundy said the papers confirmed that strain-age-hardening was dependent primarily on the nitrogen content of the steel; the lower the nitrogen content the smaller the fall in ductility on strain-ageing.

Dr. G. M. Leak, in reply to the discussion, said that Dr. Jones had stated that they had used specimens containing more nitrogen than would normally be found in a commercial steel, and that was true. They had also carried out some ageing measurements on materials containing small amounts of nitrogen, down to 0·001 or 0·002 per cent., but this became extremely difficult. They would put the limit of measurement at about 0·0005 per cent. Any measurements made on material containing 0·001 to 0·002 per cent. would give great inaccuracy, and the scatter would be so large that the results would not be very valid.

EXAMINATION OF INCLUSIONS IN IRON

The first of the two papers on inclusions was entitled "A Microscopical Examination of Samples of Iron Containing Siliceous Inclusions" and was by Mr. R. E. Lismer, of the research department of Lloyd's Register of Shipping, and Mr. F. B. Pickering, of the research and development department of the United Steel Companies Limited.

The authors stated that the object of their investigation had been to establish a means of positive identification by the determination of the optical and chemical properties of the inclusions. The crystalline constituents of the inclusions had been determined by the X-ray examination of alcoholic-iodine residues.

The whole range of inclusions represented by the deoxidation of iron by silicon had been found in the specimens examined. With increasing silicon content the inclusions varied from single-phase wüstite (FeO) through duplex fayalite-wüstite to fayalite ($2FeO.SiO_2$) and subsequently to inclusions which were glassy. Within certain ranges of silica content, two glass phases had been observed to co-exist within one inclusion. These corresponded to two liquid phases in the $FeO\text{-}SiO_2$ system.

The second paper, on "A Microscopical Examination of Samples of Iron Containing Titanium-Bearing Inclusions," was by Mr. Pickering. He stated that he had observed a considerable range of inclusions formed by the deoxidation of iron by titanium, but in many cases it had not been possible to distinguish, either optically or by means of etching reagents, the various phases identified by X-ray residue analysis. For this reason, it had not been found possible to furnish data of identification as had been done in the case of previous work of this type.

SILICON AND TITANIUM

Mr. G. E. Speight in opening the discussion said, there was now on record a very concise account of the characteristics of the known inclusions associated with deoxidation, together with microphotographs of a very excellent standard, which could not fail to be useful to metallographers in their day-to-day examinations. The silicon deoxidation series provided examples of the full range from wüstite to glassy silicates. That had been possible, as Mr. Pickering had explained, because of their high reactivity to various chemical reagents and etching media. The same scope had not been possible with the titanium series, because the inclusions formed were so very much more refractory.

The samples, however, had been made from small, 400 gm. melts, and it might be argued that in these small melts the conditions at freezing and so on were not the same as in large ingots. How would that affect the size, the shape and the constitution of these deoxidation products? Further, most commercial materials had to be examined in the wrought state. How did the further heat treatment and deformation in the solid state affect the inclusions? How would turbulence and gas evolution, as in rimming steel, affect the shape and constitution of inclusions? It might be that further comparable examinations of a few typical samples of a rimming steel, and of balanced, silicon-killed and other steels—both in the as-cast and the wrought conditions, might provide further useful quantitative data and answers to many of these practical problems. Perhaps the authors might consider the extension of their work on these lines.

X-RAY TECHNIQUES

While this work had been confined to what might be regarded as the more common techniques for the study of inclusions, newer techniques were being developed, such as electron microscopy and micro-beam X-ray techniques, and these might ultimately prove useful in the examination of inclusions.

Mr. T. H. Arnold asked whether it was a fact that it was possible to identify glassy inclusions by X-ray crystallography and, therefore, this was a tool which would determine some of the inclusions, but not all of them?

Mr. Pickering, in answer to this, said that it was quite true that the X-ray crystallography techniques were not of much help in dealing with glassy inclusions which were crystalline, and he did not know how to get over that.

In reply to questions put by Mr. Speight, Mr. Pickering said that they had started to do some work on the deformation of inclusions. It was interesting to note that their material which had been supplied by Mr. E. Ll. Evans and

Mr. H. A. Sloman at the National Physical Laboratory was high-purity material melted under rather special conditions. They had used their results, and particularly with regard to the inclusions which could be obtained in iron containing 1 per cent. of oxygen deoxidised with ordinary deoxidants such as manganese and silicon, to predict the type of inclusion found in an ordinary 18-25 lb. high-frequency melt. Hence, there was a link between the 400 gm. melt and the 18 lb. melt, and there was no reason to suppose that they could not go to still higher melts, bearing in mind that the degree of heterogeneity would probably increase with increase in size.

DEFORMATION OF INCLUSIONS

They had done a little work on the deformation of inclusions. Many American workers had tended to indicate that the transverse properties had been severely affected by various types of inclusion, probably mainly silicon inclusions, while other American workers had shown that forging treatments could be beneficial and improve the transverse properties. They had looked at some of the inclusions in alloys deoxidised by silicon and manganese, by silicon and aluminium, and by silicon alone, which had been rolled down, and they had found some interesting effects. When a glassy silicate was rolled down it became elongated and when the rolling temperature reached a certain level the inclusion started to fracture. There were fractures of this type in one of the elongated inclusions when the metal was still plastic enough to extrude into these cracks. If the metal were heated up and forged again, each of the particles of the inclusion would presumably act as a little inclusion and would elongate and then crack, and when this process was repeated the inclusions were disseminated throughout the whole mass. That might be the mechanism by which the multiple hot-working treatment improved the transverse properties, namely by disseminating the inclusion rather than drawing it out into one large streak.

Mr. B. R. Jackson asked the authors whether they had considered the approach of injecting known non-metallic materials into a vacuum-melted metal, so that, on sectioning, they would know exactly what they had present.

Mr. Pickering, in reply, said that this technique had, of course, been used previously in a great deal of work, but he had one objection to it; it produced a synthetic inclusion rather than a natural one, and it was never possible to be certain whether the natural inclusions were going to be exactly the same as the synthetic ones. He preferred to use naturally occurring inclusions.

To be continued

HYDRAULIC RESEARCH

INTERNATIONAL CONGRESS AT THE HAGUE

Concluded from page 453

The Sixth International Congress on Hydraulic Research was divided into two parts by a week-end visit to inspect the progress made with the reclamation of the Zuider Zee and also the large open-air research laboratory which has been established in the North-East Polder. This visit occupied the whole of Friday and Saturday, September 2 and 3, and involved a complete circuit of the erstwhile Zuider Zee, already considerably reduced in area and now known as the Ijsselmeer.

The party left the Hague on the Friday morning and journeyed by motor coaches to Harderwijk, about midway along the south-east shore of the Zuider Zee, which is at the southern end of the dyke enclosing Eastern Flevoland and separating it from the stretch of water which will be reclaimed eventually to form Southern Flevoland. Eastern Flevoland has an area of rather more than 200 square miles, and Southern Flevoland, in due course, will add a further 170 square miles to the land area of the Netherlands. Eastern Flevoland is roughly diamond-shaped, with its corners at the four cardinal points of the compass, and at its western extremity is being constructed the town of Lelystad, the future capital of " Zuiderzeeland," which will eventually consist of the two Flevolands and another large reclamation, Markerwaard, of about 200 square miles, still to be undertaken. A navigable channel will be left between Southern Flevoland and Markerwaard to link Amsterdam with the Ijsselmeer.

OPEN-AIR LABORATORY

The dyke which forms the north-western boundary of Eastern Flevoland is still under construction. The party proceeded along it by motorboat from Lelystad to the harbour of Schokkerhaven, on the southern shore of the North-East Polder and about halfway along the inlet which now forms the estuary of the River Ijssel, where it flows into the Ijsselmeer from the south-east. From Schokkerhaven the journey was continued by motor coaches to Emmeloord, the principal town in the North-East Polder, where most of the members remained for the night. The accommodation in Emmeloord being limited, however, some had to be housed in neighbouring construction camps and so were afforded an interesting insight into the means adopted to provide for the large floating population of workmen engaged on the work of reclamation and the subsequent establishment of farming communities in the new polders. The camps are of a standard pattern and each holds about 600 men.

The open-air hydraulics laboratory, which was visited on the morning of Saturday, September 3, occupies an area of perhaps 150 acres and borders the Vollenhover Canal, from which the necessary water supply is taken. The principal models were eight in number and related mainly to problems affecting Dutch waterways and harbours, though they also included a model of the harbour of Willemstad, in Curaçao, and another of the harbour of Lagos, Nigeria; in the former instance the investigation was nearly completed, but the Lagos model was still under construction. The Willenstad model, to a scale of 1 : 64, was for the purpose of investigating the manoeuvring of ships entering the harbour when a current was flowing past the entrance, the tests being made with self-propelled and steerable ship models, one of which was seen in use.

LAGOS HARBOUR MODEL

The Lagos model was designed to investigate shoaling problems inside the harbour and the effect on the adjacent coastline of the interruption of the littoral sand-drift by the presence of the breakwaters. The horizontal and vertical scales are 200 and 70, respectively, and the velocity scale approximately 4. The bottom material is fine sand with an average grain size of 0·14 mm., 85 per cent. being below 0·2 mm.

Another model for the examination of shoaling was one of the Rotterdam Waterway, relating particularly to new harbours to the west of the city and the influence of bridge piers on that part of the channel within the city. In this instance, the horizontal and vertical scales are 75 and 37½, respectively, and the scale of velocities is about 3. The bottom material is fine sand of similar grain size to that in the Lagos model. At the time of the visit the model was divided into two parts in order to carry out tests with an exaggerated velocity scale in both directions, but later, it was explained, the two parts would be joined, to examine the propagation of the salt-water wedge from the North Sea. No salt water being available at the site of the laboratory, its greater density would be simulated by a silt suspension in the fresh water.

Two models related to the Haringvliet, the broad channel on which stands the port of Hellevoetsluis and which separates the island of Goeree from the Dutch mainland. Its possible closure forms part of a long-term scheme of coastal reclamation extending down to the mouths of the Scheldt. One model was for the purpose of investigating the relative advantages of different sites for the closing dam, and the formation of the proposed new channels, with sluices, on both sides of the projected dam. The horizontal scale is 150 and the vertical scale 50, and the probable velocity scale about 3. As bottom material, the same fine sand is being used as in the cases already mentioned, with the slight difference that 88 per cent is less than 0·2 mm. in grain size. The model has been built in a location where this sand is found, which appreciably simplifies the work. The other Haringvliet model is one of the proposed system of sluices, to enable their capacity and the scouring effect to be studied. The horizontal and vertical scales are the same, namely, 1 : 50. The same bottom material is used as in the previous instance, but a thin layer of loam has been laid under that part of the bed which is likely to be eroded.

SCOURING OF SLUICES

Linked with the Haringvliet investigation, but based on a completed undertaking, is a model of the sluice near Kornwerderzand, at the northern end of the great dike, 20 miles long, which, in 1932, closed the Zuider Zee. At this sluice, heavy scouring occurred. It is reproduced in the model, which is to the same scales as that of the Haringvliet sluice, so that the results will be applicable also to the Haringvliet project. Associated also with the Haringvliet scheme is a model which was seen in operation, for carrying out, to various scales, fundamental research on stone dams for closing estuaries.

The eighth model represented part of the Rhine near Wijk bij Duurstede and was designed for the investigation of problems connected with the building of a weir, particularly the shoaling at the ends of the navigation canals in the region of the lock beside the weir. The scales are 50 and 25 in the horizontal and vertical directions, with a velocity scale of 3½. The bed material is granulated Bakelite with an average grain size of 2·5 mm. and a relative density of 1·5. This model, like several of the others, was seen in operation.

On leaving the laboratory, the party proceeded in the motor coaches through the North-East Polder to Lemmer, on through Friesland to Sneek and so to the dam enclosing the Ijsselmeer, which they crossed, halting on the way to inspect the sluices and the monument which commemorates the closing of the Zuider Zee on May 28, 1932. Thence they traversed the Wieringermeer Polder, reclaimed between 1927 and 1930; skirted the Beemster Polder—one of the oldest, dating from 1612; and so returned via Amsterdam and the Haarlemmermeer to the Hague.

1957 CONGRESS

The technical sessions were resumed on Monday, September 5, when papers on outlet works were discussed in the morning and the subject of instrumentation in the afternoon. A dinner was held in Scheveningen in the evening. The final technical session, on miscellaneous subjects not covered by the previous sessions, was held on the following morning. The afternoon was devoted to a business meeting, at which it was announced that Professor Straub was to be succeeded as President by Professor P. Danel, of Grenoble; and that the next International Congress on Hydraulic Research would be held in 1957—possibly in London, though this would have to be the subject of further consideration by the Council.

A NEW HARD HEAT-RESISTING CERAMIC

PRODUCTION AND USES OF "HYLUMINA"

"Hylumina," a ceramic material, was developed by K.L.G. Sparking Plugs, Limited, a subsidiary Company of Smiths Motor Accessories, Limited, Cricklewood Works, London, N.W.2, as an insulator for their range of sparking plugs, for which purpose it is now in large-scale production. It has electrical and thermal shock-resisting properties which make it ideal for this purpose, but it is by no means confined to this particular application. The properties mentioned, sometimes in combination with others it possesses, fit it for a variety of industrial uses, and there are certain applications where some of the other properties alone are ideal for particular components.

Hylumina possesses a good tensile strength—17,200 lb. per square inch, and the compressive strength of 316,000 lb. per square inch is very high. It has a hardness comparable with that of tungsten carbide, a thermal shock-resistance greater than that of any ceramic of comparable strength, it is impervious to most chemicals and resistant to all, except hydrofluoric acid. Hylumina is unaffected by temperatures up to 1,000 deg. C., and will withstand heating to 1,600 deg. C.

The material is manufactured at Treforest Industrial Estate, near Cardiff, in a factory which has been specially equipped for the purpose. The raw materials are fine-grained aluminium oxide, which constitutes 95 per cent. of the whole, a bonding material, and very small quantities of two other materials, one of which acts as a flux. Very great care is taken in the milling and grading of the raw materials, to ensure that there is no contamination, and that the grain size is consistent and of the fineness required. To produce the very fine grain size needed special equipment operated on the attrition principle by compressed air, and working in a closed circuit, is used for the final milling.

The raw materials are proportioned by weight and mechanically mixed. The mixture is then damped slightly with water to give it cohesion. In this condition it resembles in appearance damp clay, and it can be moulded and shaped by normal ceramic moulding processes. For the production of components in large quantities, the company have developed special-purpose machines to their own design, but the process is essentially that of shaping in a mould of suitable form and dimensions, allowance being made for dimensional changes when the material is fired in a subsequent operation.

In its moulded condition the material is soft and rather fragile, but has sufficient strength to withstand handling and final shaping and sizing by machining or grinding. For this purpose also, the company have developed special-purpose machines for production on a large scale. Circular components, for example, are turned, with the tool guided by a flat template, or are form-ground in an indexing grinder. The material machined or ground off, being in the unfired state, is recoverable, and is collected for re-use. When the sizing and shaping are finished, the components are packed into saggars and fired in a tunnel furnace, the time cycle being 33 hours and the maximum temperature 1,600 deg. C. After firing the material is ready for use, and cannot be machined or altered in shape in any way except by grinding with a diamond-impregnated wheel.

The uses to which components of Hylumina can be put are many and varied. Its abrasion resistance and hardness make it suitable for plug gauges and nozzles for sand and shot blasting, and the same properties, coupled with its unique frictional properties, make it particularly useful for the production of textile guides for use with certain synthetic yarns and fibres. It is also used extensively for guides in wire working and wire drawing machinery, and for similar purposes in textile spinning and weaving. Another application, which is developing, is in the manufacture of guides, pulleys and spindles for hot tinning baths for wire, where the additional qualities of heat resistance, resistance to thermal shock and also to chemical attack are necessary.

ELECTRONIC AND SPECIAL-PURPOSE APPLICATIONS

In the electrical and electronics fields the electrical properties of Hylumina make it suitable for many different purposes, and its mechanical strength is also an advantage. It can, for example, be used to replace glass in a sealed assembly. Some typical components for use in electronic work are shown in Fig. 1. For induction heating equipment Hylumina is again particularly well suited; it can be used in the heating zone as it is both heat-resisting and electrically insulating.

A specialised application, which has recently been developed, is in the manufacture of a test rig for creep-testing at elevated temperatures. Such a test rig is shown in Fig. 2. This assembly is 1 ft. 7 in. long overall, and is used for applying the test load to the specimen. It is surrounded by the heat source, and must obviously possess both mechanical strength at elevated temperatures and heat-resisting properties of a high order, since it is subjected to the conditions under which the metal specimen will eventually fail.

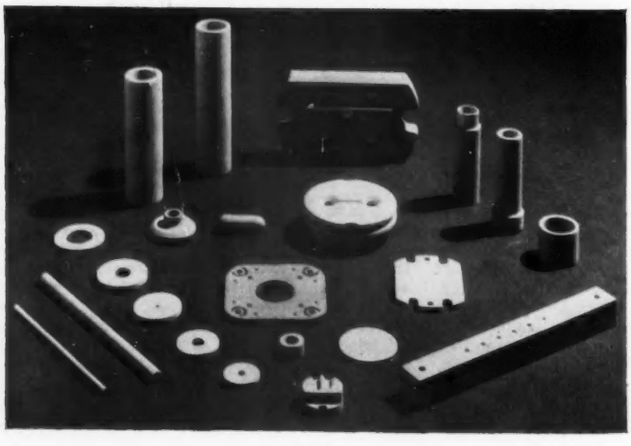


Fig. 1 Hylumina can be formed into various shapes by normal ceramic moulding methods. The components shown here are for the electronics industry.

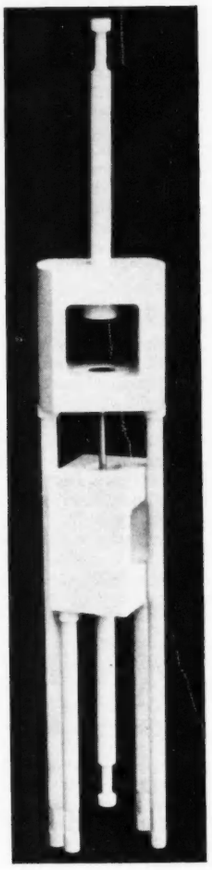


Fig. 2 A specialised application of Hylumina is in the manufacture of a creep-test rig, through which the test-load is applied, and which is subject to the same conditions as the specimen under test.

The economic aspects of the use of Hylumina depend on the nature of the component. If it is of a simple shape, which can be moulded with a minimum of labour, and in particular if it can be made in large quantities, so that mass production methods can be used, it can easily compete on a cost basis with other materials having some similar characteristics. It may, for instance, compete with tungsten carbide for applications where hardness and abrasion resistance are the dominant factors. On the other hand there are applications like the creep-test rig illustrated, which will be more costly, since they have to be made individually, but the cost will be justified by the superior characteristics of the material, which make it alone suitable for the purpose.

The material is relatively new for industrial purposes, and further applications are being developed continuously. Like all very hard materials, Hylumina has its limitations; brittleness in particular makes it unsuitable for certain work, but even here it has been applied successfully in some cases. It is impossible to lay down hard and fast rules covering its suitability for particular purposes. Each possible application is treated on its merits, and experimental work is undertaken if necessary.

★ ★ ★

AIRBORNE DIGITAL COMPUTER

An airborne digital computer in which transistors have replaced vacuum tubes has been developed for the U.S. Air Force and successfully flight tested by Missile and Control Equipment (MACE) Operations department of North American Aviation Incorporated, California.

Acting as an "electronic brain" in an aircraft, the computer automatically and continuously processes in-flight data. It can solve a number of mathematical problems in one second.

Miniaturisation techniques permitting use of some 1,000 transistors instead of vacuum tubes, and "etched" circuits of copper-clad plastics in place of conventional wiring, give this computer advantages over conventional ones.

It is more compact, occupying only 3 cub. ft. and weighing only 125 lb., and it absorbs only 100 watts. A similar vacuum-tube computer with only one-half the capacity is four times heavier, and would consume 3,000 watts.

The etched and transistorised circuits are designed in the form of 51 standardised panels for reliability and quick servicing and replacement. The computer is capable of integrating continuously 93 quantities simultaneously. It can generate continuous solutions of differential and trigonometric problems.

CLEARING BREAKDOWNS IN CONFINED SPACES

London Transport Equipment for Work in Tunnels

The very short headway of approximately 90 seconds between trains during the peak hours on the railways of London Transport Executive makes it a matter of urgent importance, apart from other considerations, that any breakdown shall be tackled with the utmost dispatch, and the enforced hindrance to the regular flow of the traffic removed as rapidly as possible. Over a great part of the mileage conditions are markedly different from those met with on ordinary main lines; the extremely restricted clearances in the tube tunnels, for example, render the work of breakdown gangs very difficult and necessitate equipment specially designed for use in the space available. It is of course impossible to work from equipment such as a crane travelling on an adjacent line in the tunnel sections, and in addition it may be necessary for the staff, with their tools, etc., to go through several other trains before reaching the disabled one, which in itself imposes restrictions on the type of apparatus that can be carried. The problem, though similar to those facing all engineers concerned with breakdown and collapse, is particularly severe and an informative account of its many aspects was given in a paper* by Mr. G. S. Bingham, Assistant Mechanical Engineer (Works) Department of the Chief Mechanical Engineer (Railways), London Transport Executive, read before the Institution of Locomotive Engineers on November 16.

ORGANISATION AND COMMUNICATION

The general organisation of the London Transport breakdown system comprises three breakdown engineers and assistant engineers, under whom are nine gangs each with a charge-hand and five to seven men, located at three places, Neasden, Ealing and Hainault, judged to be the best for covering the layout of the lines involved, and doing shift duty in such a manner that the full force of the resources can be brought to bear within the shortest possible time at any instant of the day or night. The ordinary daily occupation of those concerned is such that they are kept skilled in the type of work most suitable for a man who is called on to handle a breakdown. A constantly manned report centre, on receipt of a message from the traffic controller, dispatches the gang nearest to the incident and informs the breakdown engineer on call,.

To ensure maximum mobility and earliest possible arrival on site the breakdown equipment is carried in road vehicles, although for cases on open-air sections of line where crane facilities would be of advantage a breakdown train, with a crane of 15 tons capacity at 25 ft. radius and 30 at 16 ft., with tool vans and heavy equipment for dealing with locomotives, and accommodation for staff and engineers, is kept at Neasden, where there is a locomotive constantly in steam, ready to draw it.

The lorries are of two types, heavy and light, one of each being stationed at each of the centres mentioned, with spares at Neasden, to replace any vehicle undergoing routine maintenance. Each vehicle contains a listed set of equipment and the assistant breakdown engineer is responsible for seeing that everything used at an incident is returned and for arranging the repair or replacement of any damaged item. Every heavy lorry has a short-wave wireless transmitter and receiver, part of a radio network for railway engineering purposes which London Transport Executive is licensed to operate, with main transmitting station at headquarters which acts automatically and is used for out-going messages from the main report centre at the signal engineer's department at Earls Court. The road-vehicle transmitters operate over a much shorter distance and four receiving stations have been placed at suitable points and connected to Earls Court by land line. There is thus direct communication between the mobile transmitters and the report centre, while it is possible to connect to the London telephone system and communicate with any subscriber. The signal engineer's own breakdown vehicle has a " walkie-talkie " set communicating with the mobile stations over a one-mile range. Normally both chief mechanical and signal engineer's vehicles are dispatched to the site and when the latter arrives it handles all messages to avoid confusion. This radio communication has been found to be of very great assistance.

* " Railway Breakdown Organisation and Equipment in Use on the London Transport System."

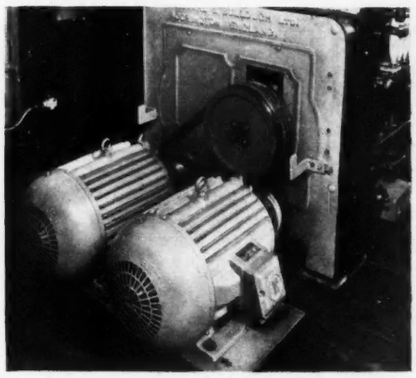
SMALL TOOLS

A considerable variety of tools is needed in order to be able to deal efficiently with any type of breakdown, but care is taken not to carry unnecessary items; the loaded weight of each heavy vehicle is 12 tons and has almost reached the maximum for the design. Great attention has been given to the selection of lifting jacks which form the basis of re-railing work. They need to be reasonably light to carry and must occupy a minimum of space when closed. The lift must, however, be as high as possible and the jack must remain stable at maximum height. Hydraulic jacks of from 5 to 24 tons capacity are carried, and screw or ratchet types ranging from 5 to 20 tons. The designs include the " Skyhi " make, of various sizes, easy to handle and simply released; the 10 ton model most frequently used elsewhere measures only 11¼ in. high when closed, but clearances beneath tube car bogies are so small that the makers designed one, specially to meet L.T.E. requirements, having a side tank, which reduced the closed height to 7⅝ in., so enabling the jack to be used between the positive conductor rail and the running rail, where space is very limited. Other jacks used are the Tangye hydraulic and screw and the Simplex ratchet types. It has been found to be very useful to be able to push against the tunnel side and a two-way screw pushing jack was developed for this. Most of the large tonnage jacks being necessarily very heavy and awkward to move, a special cradle was developed enabling two men to carry them comfortably.

Although stringent precautions are taken, including ultrasonic testing, to guard against failure of axles—always very serious and particularly so in a tube tunnel—special equipment is available in the form of different sizes of clamp and sleeve to secure temporarily a broken wheel and axle assembly and enable the vehicle to travel under caution to a depot. A broken motor axle is extremely difficult to deal with, however, and it is usually necessary to wedge and secure the wheels to the bogies and support the motor itself from the bolster by chains. This must also be done if an axle journal breaks from seizure of a roller bearing.

GAS CUTTING EQUIPMENT

Much use is made of oxy-acetylene welding and cutting plant, which the lorries carry, but care has to be exercised when using it so as to cause as little difficulty as possible later, when the item being dealt with, say a bogie frame, reaches the repair works. The men dealing with welding are craftsmen but the remainder of the breakdown staff normally recruited is from semi-skilled mechanical staff, with some electrical staff also. Special pay is allowed and the clothing necessary for the work is provided. Each lorry carries emergency rations and other arrangements are made, as circumstances may require, to ensure the gangs adequate food. The work of a breakdown engineer and his assistant and men is exacting and not made easier by the fact that it is surprisingly difficult to get accurate information as to what actually has happened in any given case, but the more reliable the information the better can he put things in motion. There may also be the question of removing persons from a train who have unfortunately been injured and that of course must take priority.



English Electric two-speed drive for a ring spinning frame with the guard removed to show the pulleys and V-belts.

IMPROVED DRIVE FOR TEXTILE SPINNING FRAMES

A Method of Reducing End-Breakages

How to obtain the highest possible production of cotton yarn of consistent quality is a problem which has long engaged the attention of the textile industry. Although its spinning cycle was intermittent the Lancashire mule did give a constant tension spin. It was, however, eventually superseded by the ring spinning frame, which had a greater production per unit of floor area, as well as a higher yarn production and continuous spin. On the other hand, when driven at a constant speed the yarn tension varied throughout the spinning period.

The yarn tension depends on the diameter of the yarn package, or cop, at the place where it is wound on to the spindle and also varies cyclically with the ring rail position. It is greatest when the yarn is wound on to the smallest diameter and least when approaching the maximum cop diameter. This variable tension creates thin places, which are known as " yarn irregularity," along the length of the yarn and the end-breakage rate is greater at the beginning and end of the spin than in the centre of the cop.

To reduce these end-breakages, and to increase the production and quality of the yarn, the English Electric Company, Limited, Queens House, Kingsway, London, W.C.2, have introduced a two-speed drive which can be installed on new and existing ring frames spinning up to counts of 90. This drive, which is illustrated herewith, consists of two identical totally enclosed fan-cooled squirrel-cage induction motors with an output of 10 h.p. at 1,455 r.p.m., which are connected to the tin roller shafts of the ring spinning frame through V-belts and pulleys. One pulley is slightly smaller than the other, so that when the motor connected to it is energised the frame runs at a lower speed than when the larger pulley is in use.

A change in speed from low to high takes place automatically when the bottom of the cop has been built and again from high to low at the nose. These speed changes are effected by cam-operated switch, which is attached by a flexible shaft to the ratchet wheel shaft of the builder motion of the frame. This switch operates two contactors, which are mechanically interlocked so that they cannot be closed together. A third contactor, which operates before either motor is energised, is provided for frames fitted with an electromechanical brake, so as to prevent snarles forming in the yarn when coming to a standstill. The setting of the speed-change switch can be changed with a screw-driver.

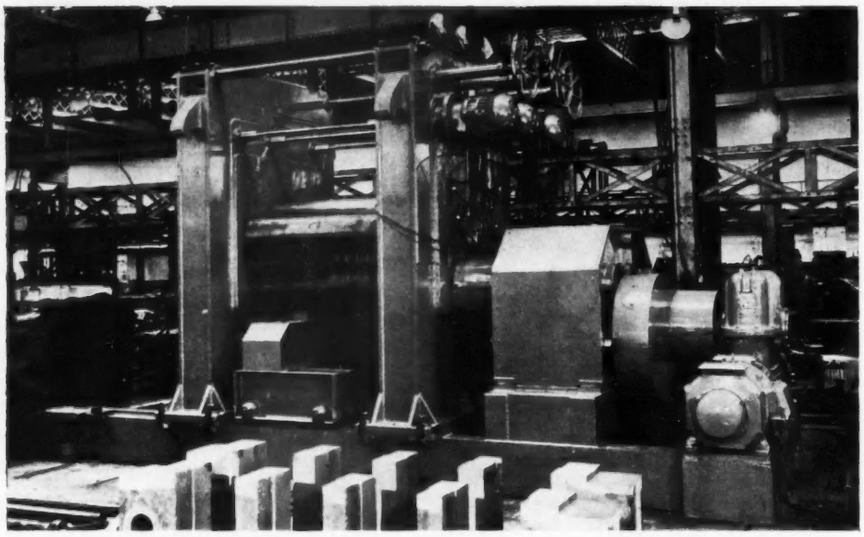


Fig. 1 Alternative positions for the outer housing on the bed-plate, and two sets of rolls, make this Bigwood plate leveller suitable for plates up to 5 ft. by 2 in. or 10 ft. by 1⅜ in.

PLATE LEVELLING AND BENDING

TWO NEW DUAL-PURPOSE MACHINES

Two machines of interest to fabricators and others who handle metal plates have been completed by Joshua Bigwood and Son, Limited, Wolverhampton.

ADJUSTABLE-WIDTH LEVELLING MACHINE

Where it is necessary to deal with plates over a wide range of widths and thicknesses, the choice of a suitable levelling machine is difficult. If the rolls are sufficiently long to level light wide plates, they will have to be very substantial to enable them to deal with narrower, heavier, plates, and the general construction of the machine will be heavy and costly. If the alternative of having two machines is adopted, heavy capital expenditure will again be involved, and extra floor space will be occupied by the two machines, which are not likely to be both at work at any one time.

The dual-purpose five-roll levelling machine illustrated in Fig. 1 has been designed and built to deal with steel plates in two width and thickness ranges; up to 5 ft. wide by 2 in. thick, or up to 10 ft. wide by 1⅜ in, thick. For this purpose it is provided with two complete sets of rolls, and one of the housings is arranged for mounting in alternative positions, according to which set of rolls is in use. The changeover from one set of rolls to the other other can be carried out in approximately four hours.

The machine is built on a heavy fabricated steel bed-plate, which carries the roll housings, gearbox and drive motor. The outer housing can be mounted in either of two positions, as required. The housings are of fabricated steel, unit construction, stress-relieved after welding; they carry the two bottom rolls in phosphor-bronze sleeve-type bearings. The three top rolls are carried in chocks in machined slideways in the housings, the weight of the rolls and chocks being balanced by heavy springs in the housings. The roll screw-down drive, which is from separate 5 h.p. geared motors, is accommodated in the housings. Handwheels are fitted for fine adjustment of the top rolls, and roll-position indicators are provided. To facilitate roll changing, lifting lugs are incorporated on the housings, the tie-bolts are located in slots and the bearing assemblies allow the rolls to be withdrawn without hindrance.

The rolls are machined from carbon steel forgings, the diameters being as follow:

Plate size	Outer top rolls	Centre top roll	Bottom rolls
10 ft. by 1⅜ in.	15 in.	19 in.	19 in.
5 ft. by 2 in.	15 in.	24 in.	19 in.

The bottom rolls are driven from a 65 h.p. reversing slip-ring motor through a heavy-duty worm gearbox and a fabricated gearbox which distributes the drive to the rolls. The roll couplings are splined, and of such a diameter that a roll can be drawn out of its bearing while the coupling is still in place. A movable jack, located on ways between the housings, supports the rolls during removal and replacement of the outer housing. The rolls are removed by an overhead crane.

MACHINE LUBRICATION

Each housing is equipped with its own centralised hand-pump grease system, which avoids the necessity for uncoupling lubrication pipes when rolls are being changed; ingress of air and dirt into the system is thus prevented. The lubricators feed the roll bearings, roll-adjusting mechanism and, in the case of the inner housing, the gearbox bearings. The gearbox gearing is of the open type, with a sheet steel guard, and is lubricated by hand.

Control of the main motor is by a reversing drum controller. The roll-adjustment motors are controlled by reversing push-button starters, which are interlocked with the adjusting handwheels, and can only be operated when these wheels are disengaged. Limit switches provide protection against over-adjustment.

BENDING OR STRAIGHTENING

It is well known that the addition of an extra roll within the housing enables a standard three-roll pyramid plate-bending machine to be used for flattening as well as bending plate. If two extra rolls are provided, more effective flattening is possible. The machine shown in Fig. 2 operates on this five-roll principle, and incorporates separate clutch control of the bending-roll adjustment and roll drive, and individual adjustment of the two outer levelling rolls. These features result in a higher operating speed.

Plates of up to 12 ft. wide by ½ in. thick can be dealt with by the machine, which has a fabricated steel bed and cast iron housings. Phosphor-bronze sleeve bearings with caps carry the two lower bending rolls in the housings, and there are machined slideways for the phosphor-bronze bushed chocks which carry the top roll and the two straightening rolls. So that the top roll may be tilted, its bearing chocks are attached to their adjusting screws by wrist pins; the adjusting screws for the straightening rolls are coupled directly to the chocks. The top roll outer bearing remains on the roll neck when the swinging end bracket is lowered for removal of a complete cylinder, thus preventing the entry of scale and dirt into the bearing. The swinging bracket is operated by hand through worm gearing; it is locked in its working position by a hand-operated pin. An extension on the top roll and a hand-operated jack enable the top roll to be supported while the end bracket is removed.

Adjustment of the top roll is by worm and wormwheel, with heavy-duty taper roller bearings to take the thrust. The drive to the worms is taken from the main gearbox through reversing clutches and cross-coupling shafts between the housings. A coning clutch, hand-lever operated, enables the top roll to be tilted for rolling cones. The straightening rolls are also adjusted by worm and wormwheel, and in this case the drive is obtained from a number of separate 5 h.p. geared motors.

Main drive is from a 25 h.p. slip-ring non-reversing motor, direct-coupled to the totally-enclosed gearbox which houses the reversing clutches for the main drive and also the top roll clutches and drive. The drive is then taken through an open gear reduction train to the bottom roll drive gears, which are keyed on to extensions of the roll necks.

All the controls are grouped, and limit switches are provided on all the power adjustments. Lubrication of the machine bearings is by grease from a central high-pressure pump system. The gears and clutches in the gearbox run in oil, and the roll and open drive gears are lubricated by hand.

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B.I.S.R.A. PERISCOPE

On page 798 of our issue of December 9, the title of a report of the Iron and Steel Institute autumn meeting refers to a B.I.S.R.A. scanning telescope; the instrument is, in fact, a periscope, normally making use of an angular magnification of ½.

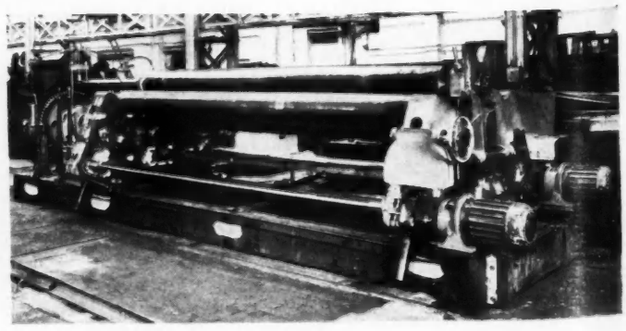


Fig. 2 By an appropriate setting of the five rolls in this machine it can be used for either levelling or bending plates up to 12 ft. wide by ½ in. thick.

LAUNCHES AND TRIAL TRIPS

S.S. "HELMWOOD."—Single-screw cargo vessel, built by Austin and Pickersgill Ltd., Sunderland, for William France, Fenwick & Co., Ltd., London, E.C.3. Main dimensions: 344 ft. overall by 46 ft. 3 in. by 22 ft. 4 in. to upper deck; deadweight capacity, about 4,600 tons on a mean summer draught of 20 ft. Direct-acting triple-expansion steam engine of reheat design, constructed by George Clark and North Eastern Marine (Sunderland) Ltd., Sunderland. Steam supplied by two marine oil-burning boilers. Service speed, 10½ knots. Launch, November 15.

H.M.S. "CONFIANCE."—Twin-screw tug, built by A. and J. Inglis, Ltd., Glasgow, for the Admiralty, London, S.W.1. First of a new class of tugs for use in H.M. Dockyards; having an overall length of 154 ft. 9 in. and a loaded displacement of 760 tons. Diesel propelling machinery provided by Rankin & Blackmore Ltd., Greenock. Launch, November 15.

M.S. "THEOMANNA ODIGITRIA.—Single-screw cargo vessel, built by Bartram and Sons, Ltd., Sunderland, for Mr. A. K. Pezas (Agents: Nomikos (London) Ltd., London, E.C.2). Main dimensions: 446 ft. 3½ in. between perpendiculars by 62 ft. by 40 ft. 2 in. to upper deck; deadweight capacity, 10,700 tons with open shelter deck and 12,700 tons with closed shelter deck; extreme draught, 26 ft. 11½ in. N.E.M.-Doxford five-cylinder oil engine developing 5,500 b.h.p. at 115 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Service speed, 14½ knots. Launch, November 15.

S.S. "STELLA AQUILA."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for Derwent Trawlers, Ltd., Grimsby. Main dimensions: 189 ft. by 32 ft. by 17 ft. 6 in.; gross tonnage, 800; fishroom capacity, 17,370 cub. ft. Triple-expansion steam engine and one multitubular oil-burning boiler, constructed and installed by Amos and Smith, Ltd., Hull. Launch, November 16.

S.S. "ELIN KNUDSEN."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Belfast, for Knut Knutsen, O.A.S., Haugesund, Norway. Main dimensions: 630 ft. between perpendiculars by 85 ft. 6 in. by 46 ft. 8 in.; deadweight capacity, about 32,000 tons on a summer draught of 35 ft. Compound double-reduction geared steam turbines, developing 12,500 s.h.p. at 112 r.p.m. in service. Launch, November 17.

M.S. "FERNCREST."—Single-screw oil tanker, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for Fearnley and Eger, Oslo, Norway. Stated to be the largest vessel so far constructed in Scandinavia and the largest Diesel-engined oil tanker in the world. Main dimensions: 682 ft. 9 in. overall by 87 ft. by 47 ft. 6 in.; deadweight capacity, 34,500 tons on a draught of about 35 ft.; oil cargo carried in 33 tanks having a total capacity of 1,660,000 cub. ft. Eriksbergs-B. and W. ten-cylinder single-acting two-stroke Diesel engine, developing 12,500 b.h.p. Service speed, 16 knots. Launch, November 18.

M.S. "OREGIS."—Single-screw ore-carrying vessel, built by William Gray & Co., Ltd., West Hartlepool, for Ore Carriers, Ltd., London, E.C.3. Fifth vessel of an order for six. Main dimensions: 407 ft. between perpendiculars by 57 ft. by 53 ft. 4 in.; deadweight capacity, 9,235 tons on a draught of 25 ft. 6½ in. Hawthorn-Doxford five-cylinder opposed-piston Diesel engine, developing 3,400 b.h.p., constructed by Hawthorn Leslie (Engineers), Ltd., Newcastle-upon-Tyne, and installed by the shipbuilders. Service speed, 12 knots. Delivered, November 21.

M.S. "RED HACKLE."—Single-screw trawler, built by John Lewis and Sons, Ltd., Aberdeen, for the Iago Steam Trawler Co., Ltd., Fleetwood, Lancashire. Third of a series of trawlers for these owners. Main dimensions: 135 ft. between perpendiculars by 26 ft. 6 in. by 13 ft. 3 in.; gross tonnage, 402; fishroom capacity, about 9,300 cub. ft. Five-cylinder Diesel engine developing 800 b.h.p. at 250 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Trial trip, November 22.

M.S. "WYRE VANGUARD."—Single-screw trawler, built by Cochrane and Sons, Ltd., Selby, Yorkshire, for Wyre Trawlers, Ltd., Fleetwood, Lancashire. Main dimensions: 127 ft. 6 in. by 27 ft. by 13 ft. 6 in.; gross tonnage, about 340; fishroom capacity, about 7,200 cub. ft. Seven-cylinder direct-reversing Diesel engine, developing 736 b.h.p. at 235 r.p.m. in service, constructed by Mirrlees, Bickerton and Day, Ltd., Stockport, Cheshire, and installed by Amos and Smith Ltd., Hull. Trial trip, November 28.

H.M.S. "LLANDAFF."—Aircraft-direction frigate, built by Hawthorn Leslie (Shipbuilders) Ltd., Hebburn-on-Tyne, for the Admiralty, London, S.W.1. Length 340 ft. overall; beam 40 ft. Main armament comprises two 4·5 in. guns and two smaller guns. Propulsion provided by Admiralty standard-range Diesel engines. Launch, November 30.

S.S. "NEVASA."—Twin-screw troopship, with accommodation for 220 first-class, 100 second-class and 180 third-class service passengers in addition to 69 sergeants and 931 troops, built and engined by Barclay, Curle & Co., Ltd., Whiteinch, Glasgow, for the British India Steam Navigation Co., Ltd., London, E.C.3. Main dimensions: 609 ft. by 78 ft. by 57 ft.; gross tonnage, 21,000. Double-reduction geared steam turbines. Launch, November 30.

AUTOMATIC HEAT-TREATMENT PLANT FOR BRASS STRIP

An electric furnace for the annealing of coiled brass strip, for the purpose of softening the metal between rolling operations, has been supplied and installed recently in the Witton Works, Birmingham, of Imperial Chemical Industries, Limited, Metals Division, by G.W.B. Furnaces Limited, Dibdale Works, Dudley, Worcestershire.

The furnace installation, which is automatically sequence-controlled thus enabling a pre-determined number of operations to be carried out, is of the resistance-heated type and is fitted internally with walking beams. These lift the coils of brass strip a few inches above the fixed portion of the hearth, move them forward a certain distance, and deposit them on the fixed hearth once again. The beams then drop down just below the fixed-hearth level and return to their original position in readiness for a new cycle of operations. The movement of the beams is arranged to be as near to the rectangular as possible and is effected by two separate motor mechanisms, one for the vertical and the other for the horizontal movement. The length of moving beam is nearly 50 ft. The furnace is U-shaped in plan and comprises an ingoing and an outgoing beam set side by side so that the vertical-lifting charging and discharging doors are adjacent. The change in travel direction of the charge is effected by means of a hydraulically-operated transfer-car mechanism inside the furnace at the base of the U.

The coils undergoing heat-treatment weigh approximately 960 lb. each and usually consist of 63 : 37 or 70 : 30 brass, the gauge being of the order of 0·120 in. or 0·160 in. and the width of the strip, 24½ in. An hourly output of 12 heat-treated coils is obtained, representing 5·15 tons an hour. The coils to be annealed are received from the preceding rolling operation down an inclined conveyor, the main axis of the coils being in the horizontal position. On reaching a manipulator at the furnace front, the coils are up-ended, so that their axis is vertical, and placed on a short slat conveyor leading into the entrance chamber through an atmosphere-lock outer door. By means of the sequence-control mechanism, the coil is passed through the inner door of the atmosphere-lock chamber and the ingoing walking beam then lifts the coil from the conveyor to start its journey through the furnace. The object of up-ending the coil when it is inside the furnace is to permit the air flow induced by furnace centrifugal fans to pass through the centre of the coils.

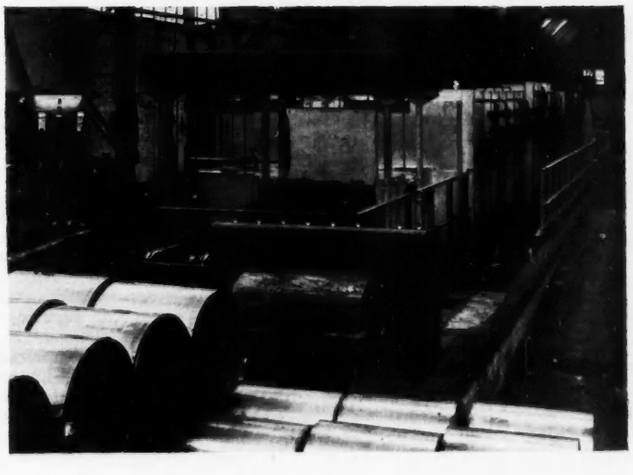
The main heating section of the furnace consists of a twin chamber having a dividing central wall and for the purpose of efficient air circulation, the length of this double section is 35 ft. The furnace wall, roof and hearth are lined with firebrick, backed with graded insulating material while the fixed hearth which supports the coils, when they are temporarily static, is capped with heat-resisting steel. Nickel-chromium strip heating elements are arranged on the wall faces and roof and heavy inverted-V-section heating elements are fitted in the hearth. Nine independently-controlled heating zones are provided. The furnace is designed for a maximum temperature of 850 deg. C., but the normal working range lies between 550 deg. C., and 600 deg. C. The consumption of current is about 80 kWh per ton when heating the metal up to 550 deg. C.

In order to achieve the maximum heat transfer from the elements to the charge, a series of centrifugal fan units are fitted in the roof of the heating chamber, there being five fans on each side.

As a continuation to the double heating chamber, a fully-bricked and insulated recuperative chamber assists in achieving the highest possible thermal efficiency since heat is recuperated by the ingoing coils from the outgoing charge. Along the outgoing section of the recuperative chamber, a series of centrifugal fans is fitted to assist the transfer of heat from the hot to the cold coils. It is stated that the ingoing coils reach a temperature of approximately 250 deg. C., before entering the heating chamber.

Finally, the outgoing walking beam places the coils on a conveyor leading to the exit chamber. This, like the entrance chamber, is fitted with an air or atmosphere lock. Moreover, in the exit chamber high-pressure water sprays are provided for final cooling. When the exit door opens, the manipulator moves across and extracts the charge, whereupon it is up-ended so that the axis is once more horizontal and the coils are transferred to a gravity conveyor to await subsequent re-rolling.

As has been indicated all the movements and operations of the installation are carried out by means of an automatic sequence-control arrangement and only one operator is needed for the whole of the heat-treatment process.



The coils of brass strip are conveyed by walking beams through the resistance-heated furnace. The operations of introduction, change of direction and withdrawal, are fully-automatic under sequence control.

Free from dust and in a controlled atmosphere, delicate mechanisms with very close clearances can safely be assembled and tested.

DUST-FREE ASSEMBLY

AIR-CONDITIONED BUILDING FOR FINE INSTRUMENTS

Where clearances are very small and exact fits are required, the presence of dust becomes intolerable. In view of this, R. B. Pullin and Company, Limited, Phoenix Works, Great West-road, Brentford, Middlesex, have erected a building, from which all dust is excluded, for carrying out the assembly and test of delicate mechanisms. One corner of this building is shown in the illustration.

The dust-free area available measures approximately 62 ft. by 48 ft. and is divided by glazed partitions to give a large central area and four smaller rooms. Entrance is by double doors from a corridor which runs along one side, and all persons entering are required to don white nylon coats. At one end, and separated from the air-conditioned section by a glazed panel, is a small workshop where items can be filed and otherwise hand worked to correct errors, etc. This shop can be seen behind the full-height partition in the illustration. There is telephonic communication between the rooms.

One of the small rooms contains a vacuum coating plant, and in one of the others gyro-stabilisers are assembled and tested. Lens blooming is also done here. Adjoining the building at one end is a pre-production shop, and at the other a standard test room where routine work can be carried out. Thus the dust-free section forms part of the actual production lines for such items as warrant this precaution during assembly. Being temperature and humidity controlled as well, any delicate work can be carried out and there is no fear of corrosion. When work is not in progress, the air-conditioning plant can be shut down and the room maintained at 65 deg. F. by a hot-water radiator system supplied from a gas-fired boiler.

The building is pressurised so that any leakage through the air lock doors is outwards. The air-conditioning plant is housed in a room above the building and uses either fresh air drawn in through a grill which can be closed by a roller shutter, or air re-circulated from the building or a mixture of both in any desired proportion. Incoming air is drawn through a "Cyclone" rotary-screen viscous filter made by Matthews and Yates, Limited, Swinton, Lancashire, this being of the type which dips in a bath of liquid at the bottom of its travel. The air is warmed (or cooled) by a heat exchanger which draws its hot water from an Evans gas-fired boiler. The water flow is thermostatically controlled. The fan is driven by a 3 h.p. induction motor and has a capacity of 5,000 cub. ft. per minute. This allows ten changes of air per hour within the building. The cleaned air is fed to two lines of trunking which run above the building and enter by a series of ventilators in the roof. Extraction is at floor level. The air-conditioning plant was supplied by Smeaton and Sons, Limited, 87 High Holborn, London, W.C.1.

The design of the building was made by Mr. J. Mendleson and incorporates a double roof to reduce heat losses and condensation. The space between the roofs is insulated with a 2 in. wood wool slab and with fibre board, and the external surface is finished with bituminised felt. Natural lighting is through concrete and glass pavement lights and continuous trough fluorescent lights provide shadowless illumination after dark. The floor is of Roflex, a latex-rubber compound which will stand hard use and remain dust free Electrical power supplies to the benches are carried below the floor and can be tapped at intervals through removable covers. The supplies include direct current at 12, 24, 115 and 220 volts and alternating current at various voltages and frequencies ranging from 50 cycles to 1,100 cycles. All are supplied from motor-generator sets housed in a separate building. Monitoring instruments for each of the supplies are mounted on one wall.

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HIGH-STRENGTH PRESSURE VESSELS WELDED

Tests at Over 10 Tons per Sq. In.

An application of the "Unionmelt" technique to the welding of pressure vessels capable of withstanding a test pressure of 27,000 lb. per square inch has recently been announced by Quasi-Arc Limited, of Bilston, Staffordshire. The vessels have a wall thickness of 7½ in. and were made to the requirements of the Cameron Iron Works, Houston, Texas. All welds were subjected to 100 per cent. X-ray testing to ensure that they were sound and porosity free.

The accompanying illustration shows the arrangement for welding, with a Unionmelt D.S.H. welding head located over the joint. 400 passes were required to deposit 265 lb. of weld metal in each of two joints, and each pass was visually inspected before proceeding. Welding speeds up to 20 in. per minute were achieved.

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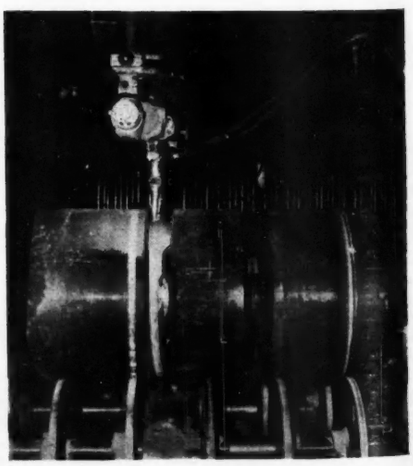
DELTIC IN PRODUCTION

Rail, Marine and Industrial Versions

The Napier Deltic engine was fully described in these columns in 1953 (vol. 175, page 555). It was then called a marine engine. Since that date, however, its use has been widely extended and it is now used to drive generating sets and a locomotive. The latter has been accepted by British Railways and made its first scheduled passenger trip on Tuesday, December 13, when it hauled the Merseyside Express from Liverpool to London. On this occasion the train consisted of 16 coaches, and a maximum speed of 91 m.p.h. was recorded. The 106 ton 3,300 h.p. locomotive will now haul the 10.10 a.m. Merseyside Express from Liverpool to Euston and return with the 4.55 p.m. Shamrock, each day.

The engine is now in production at the Liverpool works of D. Napier and Son, Limited, which were recently visited by the technical Press. The present output is fully absorbed—a large part going to foreign naval vessels—but there is still room for expansion. Both 9 and 18 cylinder versions are being made, and either can be direct-coupled to an alternator. The "Compak" set is driven by an 18 cylinder engine developing 1,725 b.h.p. at 1,500 r.p.m., giving a continuous rated output of 1,200 kW. The complete set is light enough to be carried by present-day air freighters and so forms a ready-to-run power house which can be taken to any remote site.

At present, the Deltic is not classed as a supercharged engine, although the scavenge blower does raise the charge above atmospheric pressure. Designs, are however, in hand for a turbo-charged compound version which will raise the output of the 18 cylinder engine to about 6,000 h.p. without increase in size. The engine has been designed from the first with this in view, therefore the changes involved due to the increased stresses will be very small. At this increased output the engine will have the extremely low specific weight of 2 lb. per horse-power. Tests have also been carried out with different grades of fuel, and it has been found that the standard engine will run perfectly satisfactorily on Class B marine fuel. It is thought possible that future versions will run on residuals.



Unionmelt D.S.H. welding head in position for welding heavy walled pressure vessels. The vessels have wall thicknesses of 7½ in. and can withstand test pressures of 27,000 lb. per sq. in.

PACKING FOR ALL CLIMATES

PROTECTING GOODS FROM PHYSICAL AND ATMOSPHERIC DAMAGE

The requirements of the Armed Forces during the war led to the introduction of more exacting packing specifications than had ever been used in this country before. Any goods required by the Forces had to be packed in such a way that no matter how far and in what climatic conditions they travelled, or for how long they were stored, they were in perfect condition when they were unpacked. Developments in design of equipment, and experience in transport and storage have made the work of the packer even more exacting to-day, and packing has developed into a specialised industry. It is not confined to work for the Forces. Large numbers of civilian products are now packed to the same high standard as goods for the Forces, for it has become obvious that the prestige of an exporter is enhanced by the fact that his goods arrive consistently in perfect condition wherever they are sent.

Packing to meet Ministry specifications involves specialised equipment and methods, and has to be done in premises which are themselves of an approved type. Such an establishment is "Salterpak," the Prepackaging Division of Geo. Salter and Company, Limited, West Bromwich, Staffordshire. Started in a small way after the war to pack the company's own products to Ministry of Supply specifications, the Division gradually began to undertake similar work for other concerns. It has now developed to such an extent that only a small proportion of the work done is for the company, and new premises, at Spring Road, Smethwick, Staffordshire, have been taken over and equipped to house the Division. Its premises, methods and equipment meet the requirements of the latest Specifications, Nos. 34 and 38, of the Inspectorate of Fighting Vehicles, Ministry of Supply.

To-day, nearly 100 workers are employed at Spring Road Factory, which packs about 130 tons of goods of all types each week. The goods handled range from small items such as nuts and bolts to complete electrical, electronic and mechanical equipment, the largest single item so far packed in one piece being a rubber moulding machine weighing 28 tons.

TEMPERATURE-CONTROLLED BUILDINGS

Goods arrive at Spring Road Factory by road transport. They are unloaded under cover and taken immediately into the reception warehouses, where there are handling facilities and racks for storage of the small items in bulk. Internal transport is by fork-lift trucks of the electric-battery type, this method of propulsion being chosen to prevent contamination by petrol fumes in the atmosphere of the buildings. All the floors are of non-dustmaking material. The temperature inside the buildings is maintained thermostatically at 65 deg. F.

All articles received for packing are given a thorough visual examination, and it has been found that many of those made from ferrous metals require de-rusting before they can be packed. Laboratory tests are used to supplement the visual examination when necessary. De-greasing, phosphoric acid de-rusting, and phosphating plant, together with the necessary swill tanks and drying ovens are installed, and there are also facilities for treating non-ferrous metals for the removal of oxide film. Complete assemblies which require de-rusting as a whole or in part are dismantled, treated, and then re-assembled, skilled engineering fitters being employed for this purpose.

PROTECTION WITH PLASTICS

Two of the common methods of protecting goods from atmospheric attack involve packing in polythene bags or plastic "enveloping." Small articles and assemblies are protected by being packed in polythene bags from which the air is extracted as far as possible before heat-sealing the top of the bag. A silica-gel dessicator is placed in each bag before sealing, to absorb the small amount of moisture present. The sealed bags are then built up into packages and cased as required.

For larger complete assemblies, where sealing in bags is not practicable, the principal method of protection is by plastic "enveloping." This involves the spraying of the complete equipment with an air-setting plastic which is impervious to moisture and is tough enough to withdtand handling. If the article is enclosed in a casing, such as the cabinet of a piece of electronic equipment, the plastic is sprayed on to it directly; it does not adhere to the surface, and has no effect on the paint or other finish. If the article has exposed component parts, or is of complicated shape, a covering of special paper is first applied to provide a simple contour on to which the plastic can be sprayed. The spraying is completed, and a hole is then made for the extraction of air. When this has been done the hole is sealed, and the plastic-coated goods are thus rendered moisture-free in the same way as those packed in polythene bags. The plastic coating is easy to remove when the article arrives at its destination; it is only necessary to slit the covering with a sharp knife and it can then be peeled off.

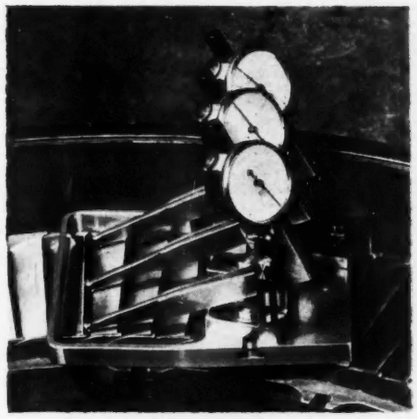
MOISTURE-FREE PACKING

Certain classes of goods, including some radar and electronic equipment, cannot be packed satisfactorily by simply excluding external moisture. During manufacture and transport to the packing factory they are exposed to the atmosphere, and collect a certain amount of moisture which, if packed and sealed in with them, may have an adverse effect over a period. Accordingly it is necessary to reduce this moisture to a harmless figure before sealing the goods.

A special "dry-room" has therefore been designed by the Company's engineers and installed at Spring-road. This room is entered through an air lock with electrically-interlocked doors, and the temperature and relative humidity are controlled to close limits at all times. The air supply for the room is first passed through a refrigerator, which precipitates the moisture, and then through electric heaters which raise the temperature to 65 deg. F. Relative humidity is maintained at 40 per cent., a recording hygrometer being used to check this figure at regular intervals. The room is operated on the plenum system and the air feeding and extracting ducts are designed to create swirl, which ensures that all parts of the room are equally swept by the air in its passage through. The extraction ducts can discharge to atmosphere or return the air for re-circulation as required.

Goods which are to be packed under moisture-free conditions are brought into the "dry-room" and stored there for at least a week. They are then packed in moisture-vapour proof bags and heat-sealed, the necessary equipment being provided in the "dry-room." After this the goods pass to the adjoining packing department where they are dealt with in the same way as other items.

In the casing of prepacked goods all necessary precautions are taken according to the nature of the goods and the treatment they can be expected to receive. Records are kept of all the principal ports and transport methods in the world, with details of climatic conditions and handling equipment, and the packing can be varied as required to suit both the article and the destination. Delicate apparatus, such as electronic equipment, is packed in a case which is then "floated" in a second case on thick sponge-rubber pads, so that shocks due to handling are not transmitted to the goods.



The three heads of this gauge for checking the throat area of gas-turbine diffuser rings operate independently and are each adjustable in three planes.

CHECKING THROAT AREAS OF DIFFUSER RINGS

Gauge with Three Heads

A new gauge for checking the throat area of the diffuser rings of aircraft gas turbines has been developed by British Indicators, Limited, Sutton-road, St. Albans, Hertfordshire. As may be seen from the accompanying illustration, the instrument provides simultaneous readings at three points between adjacent blades. Each measuring head operates independently and is adjustable in three planes; it is mounted on a pivot bearing in such a way as to ensure the automatic entry of the measuring head into the throat-area gap. Thus, the whole instrument is merely slid forward on the datum provided by the tops of the blades during the measuring operation; the minimum reading is taken as the instrument is withdrawn and the deviation from the true size is noted. Any rocking which may take place due to the unevenness of the blade edge surfaces does not affect the accuracy of the reading.

★ ★ ★

ANTI-SUBMARINE FRIGATES OF NEW TYPE

Acceptance of H.M.S. "Hardy"

An Admiralty announcement states that H.M.S. Hardy, the first completed vessel of the new Blackwood class of anti-submarine frigates, was due for provisional acceptance into naval service on December 15. Ships of this series are intended to operate in conjunction with anti-submarine frigates of the Whitby class and are provided with the latest equipment for the location and destruction of submarines. They possess great manoeuvrability and, as a result of their all-welded construction, they can be prefabricated in such a manner as to promote rapid construction.

H.M.S. Hardy, which is powered by single-screw geared steam turbines of advanced design, giving an economical fuel consumption at cruising speeds, has an overall length of 310 ft. and an extreme breadth of 33 ft. Her builders were Yarrow and Company, Limited, Scotstoun, Glasgow, who also constructed the propelling machinery to designs of the English Electric Company Limited. She is armed with two three-barrelled anti-submarine mortars, each of which can fire a pattern of large projectiles with great accuracy; all being set to explode at a predetermined depth. These weapons can be trained over a wider arc than any previous types of anti-submarine mortars. Three 40 mm. Bofors guns and two twin torpedo tubes have also been installed. The normal (peacetime) complement will be seven officers and 104 men for each vessel.

NOTICES OF MEETINGS

Aslib

LONDON
"The Documentation of History by Film," by Sir Arthur Elton, Bt. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Thurs., Jan. 12, 6 p.m.*

British Institution of Radio Engineers

LONDON
"Domestic Tape-Recording Applications, with Special Reference to Stereophonic Reproduction," by M. B. Martin and D. L. A. Smith. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Thurs., Jan. 5, 6.30 p.m.*
LIVERPOOL
"Electronic Instrumentation for Nuclear Power," by R. J. Cox. Merseyside Section. Chamber of Commerce, 1 Old Hall-street, Liverpool, 3. Wed., Jan. 4, 7 p.m.
MANCHESTER
"Radio and Television Interference: Its Growth and Effects," by M. Smith. North Western Section. College of Technology, Sackville-street, Manchester. Thurs., Jan. 5, 6.30 p.m.
NEWCASTLE-UPON-TYNE
"Some Interference Problems Associated with the Television Service," by J. C. Belcher. North Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Jan. 11 6 p.m.

British Interplanetary Society

LONDON
"Evolution of Our Galaxy," by Dr. H. P. Wilkins. Caxton Hall, Victoria-street, S.W.1. Sat., Jan. 7, 6 p.m.

Chemical Engineering Group

LONDON
"Explosions and Poisons: A Comparison of American and British Precautions," by J. H. F. Smith. Geological Society, Burlington House, Piccadilly, W.1. Tues., Jan. 10, 5.30 p.m.

Illuminating Engineering Society

LONDON
"Recent Developments in Photometry and Colorimetry," by G. T. Winch. Royal Society of Arts, John Adam-street, W.C.2. Tues., Jan. 10, 6 p.m.
BRISTOL
Various short papers on lighting installations. Bath and Bristol Centre. Royal Hotel, Bristol. Fri., Jan. 6, 7 p.m.
CARDIFF
"X-Rays in Medicine and Industry," by K. Rawlings. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., Jan. 5, 5.45 p.m.
GLASGOW
"Lighting Problems in the Coal Industry," by W. Rochester. Glasgow Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Jan. 5, 6.30 p.m.
HULL
"Street Lighting," by J. J. French. Leeds Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Mon., Jan. 9, 7 p.m.

Incorporated Plant Engineers

LONDON
Debate: "That our Main Railways be Converted into Roads." Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., Jan. 3, 7 p.m.*
BIRMINGHAM
Problems Evening. Birmingham Branch. Imperial Hotel, Birmingham. Fri., Dec. 30, 7.30 p.m.
DUNDEE
"Hospital Services," by C. N. Anderson. Dundee Branch. Mathers Hotel, Dundee. Mon., Jan. 9, 7.30 p.m.
EDINBURGH
"Materials Handling," by J. Findlay. Edinburgh Branch. 25 Charlotte-square, Edinburgh. Tues., Jan 10, 7 p.m.
MANCHESTER
Discussion on "Power Factor Correction." Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Jan. 10, 7.15 p.m.
PETERBOROUGH
Discussion on "Factory Flooring Problems." Peterborough Branch. Campbell Hotel, Bridge-street, Peterborough. Thurs., Jan. 5, 7.30 p.m.
SOUTHAMPTON
"Costing and Accountancy in Relation to Plant Engineering," by S. J. Clark. Southern Branch. Polygon Hotel, Southampton. Wed., Jan. 4, 7.30 p.m.

Institute of British Foundrymen

BRADFORD
"The Use of Refractories in the Foundry," by W. E. Ambler. West Riding of Yorkshire Branch. Technical College, Bradford. Sat., Jan. 7, 6.30 p.m.
MANCHESTER
"Practical Simple Costing in the Foundry," by G. Judd. Lancashire Branch. Midland Hotel, Manchester. Mon., Jan. 9, 7 p.m.

Institute of Fuel

LONDON
"Some Coal Research Problems and Their Industrial Implications," by R. L. Brown. Institution of Civil Engineers, Great George-street, S.W.1. Wed., Jan. 4, 5.30 p.m.*

Institute of Industrial Supervisors

GLASGOW
Annual General Meeting and Presidential Address. Glasgow Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Jan. 9, 7.30 p.m.

Institute of Marine Engineers

GLASGOW
"Nuclear Power for Commercial Vessels," by Kenneth Maddocks. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Dec. 29, 7.30 p.m.

Institute of Petroleum

LONDON
"Petroleum Fuels for Domestic Heating and Lighting," by G. F. J. Murray and D. F. Tompkins. Tues., Jan. 10, 5.30 p.m.*
ROCHESTER
Annual General Meeting and Film Display. South Eastern Branch. King's Head Hotel, Rochester. Tues., Jan 3, 7.30 p.m.

Institute of Refrigeration

LONDON
"Refrigeration Controls," by H. H. Egginton. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., Jan. 5, 5.30 p.m.*

Institute of Welding

LONDON
"Brittle Fracture of Mild Steel: A Survey," by Dr. Constance F. Tipper. North London Branch. Manson House, 26 Portland-place, W.1. Wed., Jan. 4, 7.30 p.m.*

Institution of Civil Engineers

LONDON
"Reconstruction of the Gallions Entrance Lock at the Royal Docks of the Port of London Authority," by J. A. Fisher. Maritime and Waterways Division. Tues., Jan. 3, 5.30 p.m.*
"Consolidation of Ballast," by I. G. White. Railway Engineering Division. Tues., Jan. 10, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Highland Water Power: The Development of the North of Scotland Hydro-Electric Board," by the late T. Lawrie. Thurs., Jan 5, 5.30 p.m.*
"Power-Station Auxiliary Plant," by G. F. Kennedy and F. J. Hutchinson. Joint Meeting with the Institution of Mechanical Engineers. 1 Birdcage-walk, St. James's Park, S.W.1. Fri., Jan. 6, 5.30 p.m.*
GLASGOW
"Automatic Circuit Reclosers," by G. F. Peirson, A. H. Pollard and N. Care. South West Scotland Sub-Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Jan 4, 7 p.m.
LEEDS
"The Electrical-Engineering Industry in the Post-War Economy—II," by G. L. E. Metz. North Midland Centre. Yorkshire Electricity Board, 1 Whitehall-road, Leeds. Tues., Jan. 3, 6.30 p.m.
MANCHESTER
"Highland Water Power: The Development of the North of Scotland Hydro-Electric Board," by the late T. Lawrie. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., Jan. 3, 6.15 p.m.
NEWCASTLE-UPON-TYNE
"A Criterion of Distribution Cost," by D. J. Bolton. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 9, 6.15 p.m.
PORTSMOUTH
"Receiving Aerials for British Television," by F. R. W. Strafford. Southern Centre. College of Technology Extension, Portsmouth. Wed., Jan. 4, 6.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Mechanical Services in the British European Airways Hangars at London Airport," by L. Copeland Watts and J. W. J. Leslie. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham 2. Thurs., Jan. 5, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Power-Station Auxiliary Plant," by G. F. Kennedy and F. J. Hutchinson. Joint Meeting with the Institution of Electrical Engineers. Fri., Jan. 6, 5.30 p.m.*
"Overdrives and Their Control," by S. H. Ashby. Automobile Division. Tues., Jan. 10, 5.30 p.m.*
"Instrumentation for Smoke Control in Small Boiler Plants," by A. E. Glaysher. London Graduates' Section. Wed., Jan 4, 6.30 p.m.
BEDFORD
"Hydraulic Transport of Solids," by R. C. Worster and Dr. D. F. Denny. Annual General Meeting. Eastern Branch. Dujon Restaurant, Bedford. Thurs., Jan. 12, 7.30 p.m.
LEICESTER
Annual General Meeting. Thomas Hawksley Lecture on "The Properties of Matter at High Pressures," by Professor D. M. Newitt. East Midlands Branch. College of Technology, Leicester. Tues., Jan 10, 6.30 p.m.

Institution of Production Engineers

COVENTRY
"Production of Piston Rings," by H. C. Blackford. Coventry Section. Craven Arms, High-street, Coventry. Tues., Jan. 10, 7 p.m.
LEEDS
"Automatic Inspection: The Anatomy of Conscious Machines," by J. A. Sargrove. Yorkshire Section. Hotel Metropole, King-street, Leeds, 1. Mon., Jan. 9, 7 p.m.
NOTTINGHAM
Informal Discussion Meeting. Nottingham Section. Victoria Station Hotel, Nottingham. Wed., Jan. 4, 7 p.m.
OXFORD
"Cost Accounting as an Aid to Efficient Production," by H. J. Furness. Oxford Section. Town Hall, Oxford. Tues., Jan. 3, 7.15 p.m.
SOUTHAMPTON
"Economic and Social Effects of Automation," by R. R. Williams. Southern Section. The University, Southampton. Thurs., Jan. 5, 7.30 p.m.
WOLVERHAMPTON
"Forgings and Pressings in High-Strength Aluminium Alloys," by J. E. Earl. Wolverhampton Section. Wed., Jan. 4, 7.15 p.m.

Institution of Railway Signal Engineers

YORK
Open Meeting to be held jointly with the Permanent Way Institution. Railway Institute, York. Tues., Jan. 10, 5.30 p.m.*

Institution of Structural Engineers

LONDON
Discussion on "Engineering in Europe and America." London Graduates' and Students' Section. Wed., Jan. 4, 6.30 p.m.
"The Application of an Electronic Digital Computer to Some Problems of Structural Analysis," by Dr. R. K. Livesley. Thurs., Jan. 12, 6.30 p.m.
BRISTOL
Open Meeting. Western Counties Branch. The University, Bristol. Fri., Jan. 6, 6 p.m.
NEWCASTLE-UPON-TYNE
Open Meeting. Northern Counties Branch. Neville Hall Westgate-road, Newcastle-upon-Tyne. Wed., Jan. 4, 6.30 p.m

Institution of Works Managers

BIRMINGHAM
"Management as Seen from the Shop Floor," by L. Pridmore. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Tues., Jan. 10, 7 p.m.
MANCHESTER
"Educational Training for Industry," by Lady Simon of Wythenshawe. Manchester Branch. Grand Hotel, Manchester. Mon., Jan. 9, 6.45 p.m.

Junior Institution of Engineers

LONDON
Question and Discussion Evening. Fri., Dec. 30, 7 p.m.
Film Evening. Fri., Jan. 6, 7 p.m.
BIRMINGHAM
"Josiah Wedgwood: The Potter," by Miss R. J. Warne. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Jan. 4, 7 p.m.
SHEFFIELD
"The Factory Acts," by D. E. Jones. Sheffield Section. Livesey Clegg House, Union-street, Sheffield. Mon., Jan. 9, 7.30 p.m.

Manchester Association of Engineers

MANCHESTER
"Polythene and Its Uses," by A. Renfrew. Engineers' Club, Albert-square, Manchester. Fri., Jan. 6, 6.45 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Steel for Shipbuilding," by T. F. Pearson. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Fri., Jan. 13, 6.15 p.m.

Reinforced Concrete Association

LIVERPOOL
"Selection and Grading of Aggregates for Various Types of Concrete Works," by J. D. McIntosh. North Western Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Jan. 4, 6.30 p.m.*
MANCHESTER
"Selection and Grading of Aggregates for Various Types of Concrete Works," by J. D. McIntosh. North Western Branch. College of Technology, Sackville-street, Manchester. Tues., Jan. 3, 6.45 p.m.*

Royal Aeronautical Society

LONDON
"Test Flying: Current Problems and Techniques," by Wing Commander R. P. Beamont. Young People's Lecture. Institution of Civil Engineers, Great George-street, S.W.1. Thurs., Jan. 5, 3 p.m. (Tea at 4.30 p.m.)
"Some Modern Structural Problems," by Professor W. S. Hemp. Tues., Jan. 10, 7 p.m.

Royal Society of Arts

LONDON
"How Clocks and Watches Work," by A. W. Marshall. Fri., Dec. 30, 2.30 p.m.

Royal Society for the Promotion of Health

LONDON
"Housing Repairs and the Rent Acts," by J. Clancey, at 10.30 a.m. "Slum Clearance," by Major D. J. E. Lamb; and "Grants for Improvements and Conversions," by J. E. Austin, at 2 p.m. Caxton Hall, S.W.1. Wed., Jan. 11.

Sheffield Metallurgical Association

SHEFFIELD
Annual General Meeting of the Methods of Analysis Group, 6.30 p.m. "The Use of Statistical Design in Chemical Analysis," by G. A. Coutie, 7 p.m. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield, 3. Tues., Jan 10.

Society of Instrument Technology

LONDON
"Liquid-Flow Control," by B. W. Balls. Control Section. 26 Portland-place, W.1. Thurs., Jan. 12, 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Aslib (Association of Special Libraries and Information Bureaux), 4 Palace-gate, London, W.8. (WEStern 6321.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough-gardens, London, S.W.1.
Chemical Engineering Group, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham 4. (Midland 6971.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1. (SLOane 9851.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square. Lonon, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street London, W.1. (GROsvenor 5254.)
Institution of Railway Signal Engineers, Euston House, Eversholt-street, London, N.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Institution of Works Managers, 67-68 Chandos-place, London, W.C.2. (TEMple Bar 8324.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, 1. (Newcastle 20289.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Society for the Promotion of Health, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Sheffield Metallurgical Association, 15 Crescent-road, Sheffield 7. (Sheffield 53674.)
Society of Instrument Technology, 184 Sherwood Park-road, Mitcham, Surrey. (POLlards 3620.)

In Parliament

RURAL NEEDS IN TRANSPORT

In a debate on the Rural Transport Improvement Bill, the second reading of which was moved by its sponsor, Mr. Archer E. Baldwin (Unionist), stress was laid on many aspects of communications in country areas. Mr. Baldwin said that the Bill was designed to effect improvements in all forms of rural transport, by road, railway and canal, and pointed out that the lack of these facilities was one of the principal causes of the existing drift from the countryside.

He believed that if the nation was to get a progressive up-to-date inland waterways system, the canals must be separated from the British Transport Commission. The less remunerative waterways, instead of being closed, should be modernised, to take some of the heavy traffic off the roads. The one thing which was essential was to reduce the amount of traffic on the roads. The various clauses of the Bill provided that when the Commission desired to close a branch railway line it must give notice of its intention in the local newspaper and to every local authority in the area; that any person could request the Transport Tribunal to ask the Commission to show cause why the use of the line should be discontinued; and that, when such applications were made, the Transport Tribunal should be required to hold a public local inquiry.

A feature of the Bill was the provision that the Transport Tribunal might include in its decision a requirement that the Commission should dispose of the line concerned to the highest bidder. It was not right that the Commission, which was a privileged body, should close a railway and refuse to operate it when others were prepared to take on that responsibility. The closing of a small section of a railway for both passengers and goods often made a long length of line ineffective and people were compelled to go a long distance round to get where they wished to go. He had found that 80 per cent. of the bus services in rural areas were under the control of the Commission and he regarded this as a disturbing feature.

ROADS FOR RAILWAYS

Mr. Baldwin referred to the possibility of using Diesel railcars and electric-battery vehicles on the less remunerative lines, and quoted figures illustrating the relatively low cost of their operation. Mr. David Renton (National Liberal and Unionist), who seconded the motion for the second reading, emphasised that the Bill would not compel the Commission to continue to operate any line which it could prove to be unremunerative.

Out of 118 cases involving the closing of branch lines which came before the consultative committees up to the middle of this year, there were only two instances in which these committees asked the Commission to reconsider its decision. It was to be hoped that, when the Transport Tribunal finally decided that a line must be closed and could not be operated by anyone, even as a light railway, the possibility of the conversion of the line into an ordinary road would be considered.

A suggestion was put forward by Mr. W. G. Leburn (Unionist) that, where orthodox methods of transport might prove uneconomical, other methods, such as small vehicles carrying only a few passengers and having a driver who collected the fares, should be used. Mr. Clifford Kenyon (Labour) expressed the view that almost the whole purpose of the Bill could be dealt with by means of existing legislation. The solution to the problem was the provision of a comprehensive co-ordinated service of railway, road, sea and canal traffic throughout the length and breadth of the country, in which the profitable sections compensated for losses incurred by other sections. Mr. J. E. B. Hill (Unionist) said that cost was involved in leaving a railway track unoccupied, even if it was only to keep the drainage going and preventing the line becoming a nuisance. He suggested that the cost of such maintenance should be offset against the operation of light Diesel railcars. The difference might not be very great.

OPERATION OF DIESEL RAILCARS

The Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, Mr. Hugh Molson, referred to important new developments being investigated by the Commission, one of which, the multiple-unit Diesel railcar, was proving extremely satisfactory. Figures for the West Cumberland group of services, centred round Carlisle, showed that operating costs there had been reduced from £150,000 to £80,000 per annum in spite of an increase of 30 per cent. in the mileage operated. Receipts had risen from £45,000 to £70,000 per annum. Even these improvements, however, had not resulted in receipts covering outgoings, though the gap had been greatly diminished and it was hoped that the gap would be completely removed in time.

Another of the Commission's experiments was with light four-wheeled Diesel train sets, such as those which ran between St. Albans and Watford. This type did not show any great advantage over the bogey multiple-unit type. Three carriages cost approximately £22,000, compared with the cost per multiple unit of £26,000 for two carriages. Although cheaper it was not a great deal cheaper. Again, the seating capacity, even with these train sets was greatly in excess of what was required for rural services. Unfortunately, too, the steel tyres on these light wheels wore out after 10,000 miles, compared with 60,000 miles in the case of the tyres on the bogey wheels of multiple-unit Diesel railcars.

The Government did not think the proposals contained in the Bill in its existing form to be either satisfactory or workable. They were anxious, however, to meet what they believed to be the reasonable wishes of rural communities for a full, public and fair consideration of any proposals for closing rural lines.

The motion for the closure was moved by Mr. Baldwin, but this failed to obtain the majority prescribed and the debate was adjourned.

ELECTRICITY SUPPLY IN SCOTLAND

Various questions regarding the work of the North of Scotland Hydro-Electric Board were asked by Mr. G. Nabarro (Unionist). In answer to one of these, he was imformed by the Secretary of State for Scotland, Mr. James Stuart, that the total installed capacity of the Board's generating stations at November 30 last amounted to 625,300 kW. Of this total, 479,000 kW was the capacity of their hydro-electric plant, 103,000 kW of their coal-fired steam plant and 43,300 kW of their Diesel-engined plant.

Mr. Stuart said that the Board had made surveys in the Loch Awe area for both a conventional hydro-electric project, with an installed capacity of about 75,000 kW, and a pumped storage project, with an installed capacity of about 350,000 kW. The Board, however, had not yet submitted to him a constructional scheme giving estimates of costs.

On the subject of the Board's financial commitments, Mr. Nabarro inquired whether, in view of the total of these amounts and the fact that schemes under construction would ultimately cost much more than the sums sanctioned, the Secretary of State would consider introducing legislation to deal with the statutory limit of £200 million imposed on the Board. Mr. Nabarro gave the financial items as £117,300,000 in respect of expenditure on capital account to the end of October, 1955; a further £62,350,000 committed to in respect of unfinished projects; and £2,155,000 for schemes sanctioned but not yet commenced. Mr. Stuart replied that there was no immediate need to increase the Board's borrowing limit of £200 million.

Disposal of Warships

One cruiser, one destroyer, nine frigates and two ocean minesweepers are to be scrapped shortly, according to a reply given by Commander Allan Noble, R.N. (retd.), Parliamentary and Financial Secretary to the Admiralty, to Mr. L. J. Callaghan (Labour). As to replacements, ships under construction on March 31, 1955, included three cruisers, 26 frigates and a large number of coastal and inshore minesweepers.

Tests of Flame-Resistant Materials

Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works, informed Mrs. Jean Mann (Labour) that the Joint Fire Research Organisation of the Department of Scientific and Industrial Research was ready to test materials for flame resistance on behalf of manufacturers and bodies concerned with fire precautions and safety. Applications for tests should be addressed to the Joint Organisation at the Fire Research Station, Boreham Wood, Hertfordshire.

Asked if the research on flame-resistant material conducted by the Department had produced a chemical compound which would meet the requirements of the inter-departmental committee in regard to texture, shrinkage, cost, skin-rash, washing-out, and the elimination of glow or char, Mr. Bevins said that the work of the Joint Organisation, in collaboration with industry, was concerned with tests to assess the value of methods of treatment. He understood that the textile industry, both in Britain and America, was studying methods of flame-proofing fabrics.

Exhaust Gases from Motor Cars

Asked by Mr. R. S. Russell (Unionist) about the emission of exhaust gases from Diesel-engined motor vehicles, Major Gwilym Lloyd-George, Secretary of State for the Home Department, said that five summonses and 115 written cautions were issued in respect of the emission of gas from motor vehicles during the twelve months ended September 30 last. No separate record was kept of the type of engine concerned or of the number of oral warnings. He could not at present say whether or not Diesel-engined vehicles were the main offenders, but, from his own observation, it seemed probable that these vehicles might emit a good deal of smoke. He added that he was in consultation with the Minister of Transport and hoped to be able to do something about the problem.

Technical Assistance to Ceylon

In a series of written answers to questions asked by Mr. R. G. Page (Unionist), the Under-Secretary of State for Commonwealth Relations, Mr. Douglas Dodds-Parker, stated that 72 Cingalese trainees sponsored by his Department were in the United Kingdom. He said he considered that that figure reflected satisfactory progress on the trainee side of the United Kingdom programme of technical assistance to Ceylon, under the Technical Co-operation Scheme of the Colombo Plan. Under that Plan, 41 experts and advisers had been provided by the U.K. Government to Ceylon. They were engaged on 30 separate projects, mainly in the fields of engineering, railways, medicine and taxation.

No technical assistance had been given to United Kingdom concerns desiring to participate in enterprises in Ceylon as, under the Plan's Technical Co-operation Scheme, technical assistance was provided to Governments and not to business concerns.

Underground Gasification Experiments

The Minister of Fuel and Power, Mr. Geoffrey Lloyd, told Mr. T. E. Watkins (Labour), that no proposals had so far been considered for underground gasification experiments on new sites.

Steel Imports

In a written answer, Mr. A. R. W. Low, Minister of State for the Board of Trade, informed Lady Tweedsmuir (Unionist) that information was not available respecting the proportion of small mild-steel reinforcement rods which are dependent on billets imported from abroad. The production of billets in Britain for light rolled products, including reinforcing rods, was being supplemented during this year by imports to the extent of 5 per cent.

THE HUMAN ELEMENT

What is a profession? the teacher's place—Casualties in the mines—Improved machinery but fixed piece-rates—Prospects for continued full employment—Employment of discharged prisoners—New Year greetings to the Unions.

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A Craft or a Profession?

The National Union of Teachers have not enhanced the reputation of their members as professional people. To suggest to them that they should "work to rule" and refuse to collect school savings, dinner money, supervise meals or do other tasks outside "working hours" is tantamount to asking them to give up their professional status. The issue over which all the trouble has arisen is the suggestion that teachers should make a small contribution to their superannuation scheme. The N.U.T.'s objective is based on the fact that teachers' pay is already most inadequate and that to take something out of the monthly cheque, however small, is making a bad situation worse. So it is, but even if it was the declared intention of the Government to lower teachers' salaries by exacting a contribution to pensions—which it is not—it would still be no excuse for acting in a way which schoolchildren should not have to witness, and which is hardly likely to increase the latter's respect for authority.

The Minister for Education, Sir David Eccles, has publicly stated the Government's intention "to improve the status of teachers." There is much sympathy, in Parliament and elsewhere, for any claim the N.U.T. might make for a substantial rise in the salaries of its members. Indeed it is in the nation's interest that they should do so, for there is no question that teachers' incomes are much too low and not at all in keeping with their professional status. A teacher's dignity and pride in his calling—which call for a remuneration well above that earned by the mass of the people—are inseperable from his ability to teach and to inculcate in children the code of personal and social ethics we value. Another vital consideration is the shortage of able recruits to the profession, which is a direct result from the unequal opportunities it has to offer compared with industry and other professions. The right policy therefore would be to press for salary increases, which could be more effective than any set of rules in raising teachers' status and in securing that they are not asked to perform menial tasks.

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Accidents in Engineering Work

It might be expected that accidents, fatal and otherwise would increase as activity in the engineering industry went up, but this does not appear to be so. According to the report for 1954 of the Chief Inspector of Mines which has just been published, accidents at works of engineering construction were the lowest in 1954 since 1951. The number of fatal accidents and the ratio of fatal to total accidents was also the best since that year. On the other hand, accidents during the installation of plant were higher in 1954 than in 1953—the increase being largely due to a remarkable increase in the number of persons struck by falling objects.

In building operations the number of accidents has been rising each year over the last six, but in 1954 the number of fatal cases was the lowest since 1949 (the first year given in the table). About 70 per cent. of accidents in this industry were due to falls. Among crane accidents, a big number were caused by crushing between load and sling or some other object, or of persons being hit by a swinging load or by the load falling from the sling. A feature among transport accidents in factories was the high percentage caused in manhandling hand-powered barrows and trucks. One black spot was the increase in accidents at power presses after a seven-year downward trend. There is still a hard core of tool and die presses without guards, and a disturbing number of skilled workers are still working trial pressings without guards. Installation of protective measures at die-casting machines is still too slow, says the report. The trend of accidents with electricity (fatal and otherwise) is still downward.

Accidents caused by power-driven machinery in factories increased in 1954 from 25,727 to 26,221. Over half the total is not classified in the report but among those which are, the largest number of accidents continue to be among lifting machinery and circular saws. So far as the last is concerned, there was a small reduction in the number of accidents last year. Accidents with planing machines increased rather more than the average and there was a serious increase in those recorded for rollers of calenders and mixers. It is gratifying to note that despite an increase in the number of accidents over the year by about 2 per cent. for this type of machinery, the fall in the number of accidents recorded since 1947 has been as much as 15 per cent.

These are only a few of the points from the 1954 report which is, as usual, full of information and woefully late in appearing.

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Cotton Wages and Piece-Rates

Union leaders of 260,000 Lancashire cotton operatives decided last week to present a new claim for a 10 per cent. increase in wage rates. If conceded in full, this would add £10 million a year to the industry's wage bill and is considered a most serious threat to the industry's already precarious position, particularly in export markets. Shortly after the claim was lodged, the weaving employers proposed a reduction of piece-rate payments for the largest section of the industry. The Cotton Spinners and Manufacturers' Association, which represents some 1,000 mill owners, announced that its central committee had decided to ask the Weavers Amalgamation—by far the largest manufacturing union—to consider jointly with them "substantial reductions" in the percentage additions for rayon in the uniform lists for weaving. These rates, they say, were agreed 30 years ago, since when "technical improvements in rayon have generally reduced the difficulties in weaving it."

The issues raised by the employers' counter-attack—if the move was prompted in any way by the wage demand—are far-reaching indeed, and there is little doubt that there will be strong opposition to a reduction of piece-rates. Similar situations exist in a great many of our manufacturing industries, where the materials or the machinery available have improved and permit very high earnings for some operatives. In some cases heavy capital expenditure has been incurred to bring about the change and there is no doubt that the employers have a case. This lack of flexibility in piece-rates once they have been agreed is one of the reasons for their fall from favour in many enterprises, particularly in the United States. Another is that they are said to be out-of-date and relatively ineffective as a means of increasing worker-effort. To allow such situations to persist is as harmful to the workers' interests as it is to those of the employers.

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Employment Continues Very Full

There is little in the latest employment statistics issued by the Ministry of Labour and National Service to suggest that the credit squeeze is reducing the number of jobs available. Employment in manufacturing industry at the end of October was 52,000 higher than a month previously and 212,000 higher than a year ago. Unemployment was still only 1 per cent. of the estimated total number of employees. There was a reduction of 4,000 in the strength of the Forces, which should decline at a quicker rate during the next few months until the target figure of 700,000 is reached.

Employment in the metal and engineering industries was up 25,000 on the September figure and 198,000 higher than a year ago. The largest gains were made by the vehicle industries, amounting to 5 per cent. during the year. Mechanical and electrical engineering gained 4 per cent., and the metal manufacturing industries 3 per cent. All three groups are still acutely short of workers although great strides have been made towards economy of manpower and higher productivity. This is shown by the production index of these industries which rose by 11 per cent. (average montly increase) during the eleven months to September.

Few would suggest that further progress in this direction cannot be made, and there is every reason to expect a slight fall in the demand for labour to result from the restriction of credit by the banks. On the whole therefore the shortage of labour should become rather less acute during the next few months although it is most unlikely that there will be any increase in unemployment.

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After-Care of Prisoners

A case is quoted in the 1954 annual report (recently published) of the Council of the Central After-Care Association of an employer who gave a man the job of taking the firm's takings to the bank, although it was known that he had served a sentence of preventive detention. Examples of this kind, isolated as they may be, underline two things. They remind the reader that a man's punishment ends with his sentence and also that such organisations as this association have an uphill fight.

The report this time covers four main topics. First, it draws attention to the question of whether it would be desirable for persons serving long sentences to undergo a transitional period of supervision. Second, the statistics show that women and girls are less liable to be convicted of criminal offences than men and boys and also less liable to re-conviction and recidivism. Attention is drawn to the particularly intractable problem of homeless persons on release. There is also a section on the resettlement of prisoners after release from preventive detention.

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Home Thoughts from Abroad

When the general secretary of the T.U.C. recently went to the United States he left behind him his thoughts on the New Year for the trade union movement. A fraternal greeting from the Trades Union Congress to its member unions is customary at this time of the year. It is naturally topical and, as befits the occasion, it is always a judicious mixture of congratulation and exhortation. This last part is never far removed from the main preoccupation of the T.U.C. at the particular time and it is noticeable that the message for the New Year conveys an oblique warning for those who spurn the protection of unity and the strength of orderly trade union procedure.

"There is no doubt," says the message, "that trade unionists have every right to be bitterly resentful when employers break agreements freely negotiated through the machinery of collective bargaining. But they should never forget that they too have a part to play in upholding agreements entered in or on their behalf. Those who decide to grab what they can and to 'go it alone' can seriously undermine the essential sanctity of collective bargaining. Because of them we might one day have to fight again battles we have already won." There isn't much dogma or doctrine in such a statement and it could have come from no trade union organisation in the world but a British one. It breathes earthy commonsense—but we may need a lot of that from the trade union movement in 1956, so the unions could find a worse framework to set them off than the season's greetings.